4-13-2017

The Effects of Aerobic Exercise on Repetitive Behaviours and Task Performance for Adults with Autism Spectrum Disorder and an Intellectual Disability

Suzanne Ali
University of Windsor

The Effects of Aerobic Exercise on Repetitive Behaviours and Task Performance for Adults with Autism Spectrum Disorder and an Intellectual Disability

By

Suzanne Hafiza Ali

A Thesis
Submitted to the Faculty of Graduate Studies
Through the Department of Kinesiology
in Partial Fulfillment of the Requirements for
the Degree of Master of Human Kinetics
at the University of Windsor

Windsor, Ontario, Canada

2016

The effects of aerobic exercise on repetitive behaviours and task performance for adults with autism spectrum disorder and an intellectual disability

by

Suzanne Hafiza Ali

APPROVED BY:

_____

C. Abeare
Department of Psychology

_____

P. van Wyk
Department of Kinesiology

_____

S. Horton, Co-Advisor
Department of Kinesiology

_____

N. Azar ,Co-Advisor
Department of Kinesiology

December 21, 2016

DECLARATION OF ORIGINALITY

I hereby certify that I am the sole author of this thesis and that no part of this thesis has been published or submitted for publication.

I certify that, to the best of my knowledge, my thesis does not infringe upon anyone's copyright nor violate any proprietary rights and that any ideas, techniques, quotations, or any other material from the work of other people included in my thesis, published or otherwise, are fully acknowledged in accordance with the standard referencing practices. Furthermore, to the extent that I have included copyrighted material that surpasses the bounds of fair dealing within the meaning of the Canada Copyright Act, I certify that I have obtained a written permission from the copyright owner(s) to include such material(s) in my thesis and have included copies of such copyright clearances to my appendix.

I declare that this is a true copy of my thesis, including any final revisions, as approved by my thesis committee and the Graduate Studies office, and that this thesis has not been submitted for a higher degree to any other University or Institution.

ABSTRACT

Repetitive behaviours (RB) are one of the main characteristics of Autism Spectrum Disorder (ASD). RB are related to a decrease in adaptive functioning for people with ASD and 31% of people with ASD are diagnosed with an Intellectual Disability (ID). The purpose of this study was to assess the effects of aerobic exercise on RB expression immediately after a single session and over the course of several sessions, and its ability to improve task performance for adults with ASD and ID. Six case studies were conducted, where participants exercised on a stationary bike twice a week for eight weeks. Video observations and the Jebsen Hand Function Test (JHFT) were conducted immediately pre- and post-exercise. The Repetitive Behaviour Scale-Revised (RBS-R) was administered to a support worker, parent, or guardian pre- and post-intervention. The changes that occurred in RB from the video observations were specific for each individual. Further analysis suggested an interaction between certain RB (i.e., *pacing* and *body rocking*), and that some RB are positive expressions and do not need to be reduced. The JHFT indicated that, for most participants, RB may not influence performance on short-duration tasks. Due to the variable results, the RBS-R was not a reliable measure of changes in RB severity for this study. The case studies conducted provided important information on each participant, their RB, and their progress throughout the program. Future research would benefit from identifying and reducing specific RB that are deemed maladaptive rather than attempting to decrease all RB.

DEDICATION

Dad,

For all the times you told me that school should be 'elementary' by now.

Mom,

For being there when I tried to explain to Dad that school gets harder.

ACKNOWLEDGMENTS

The following is a list of people who made completing my Master's degree possible. Your continued support allowed me to grow as an individual and I will be forever grateful.

Sean Horton and *Nadia Azar*: for believing that I can achieve more. I thank you both for your patience, your knowledge, the amount of time you spent helping me, your compassion, and for allowing me to pursue a topic that I was passionate about. Individually your friendship is irreplaceable. I could not have asked for a better pair of advisors to guide me, thank you.

Chad Sutherland: for being my honorary committee member. I have appreciated your ability to see things that others have missed. Thank you for the time you spent helping me with my project.

Paula van Wyk: for your deep passion around equality. Thank you for being my internal committee member.

Christopher Abeare: for inspiring me in your classes and for being an intelligent, but approachable person. Thank you for being my external committee member.

Vicky Paraschak: for your compassion and caring personality. Thank you for chairing my thesis defense.

Lynne Shepley and *Lori Huson*: for being two of the most wonderful people to work with. Your support in conducting this project was irreplaceable.

Community Living Essex County: for the warm welcome from everyone and for the staff who stayed past working hours to make sure I could finish conducting my program.

Southern Network of Specialized Care: for the work that you do and for funding this research project.

Mom: for your kind loving heart that shows through everything you do and for helping a much younger reluctant version of myself finish all of her homework.

Dad: for your wisdom and strength of character, qualities that I will always cherish.

Kate Paquin: for embodying the definition of what a true friend is and for always helping me to look at the bright side.

Cyril Sabutsch: for your unconditional love all of these years and unwavering support. I could not have gone through this journey without you.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER 1: Introduction

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder that is characterized by deficits in social and communicative functioning, as well as behaviours, interests and activities that are restricted and repetitive in nature (APA, 2013). The current prevalence of ASD in the United States is 1 in 68 children, with prevalence rates specific to Southeastern Ontario rising 13% between 2003 and 2010 (Centre for Disease Control and Prevention [CDC], 2016; Ouellette-Kuntz et al., 2014; Wing & Potter, 2002). In addition to the social, communicative, and behavioural barriers, 31% of individuals with ASD also have Intellectual Disability (ID; CDC, 2014). ID is classified as having impairments in both intellectual and adaptive functioning, illustrated by having an IQ score approximately two standard deviations below their typically developing peers (APA, 2013). As a result, they may also have difficulties with judgment, problem solving, and learning.

The increasing prevalence of ASD, and the effects of lifelong barriers, highlights the importance of interventions for people with ASD to improve their quality of life (Murphy et al., 2005). Similarly, the majority of ASD-related expenses occur after the age of 21 years (Ganz, 2007), suggesting that support is needed for adults with ASD. The families of a person with both ASD and ID are more likely to quit work to take care of that individual than compared to people with ASD or ID alone (Ouyang et al., 2014). Therefore, due to the rising prevalence, lifelong impairments, increased complexity with the co-occurrence of ID, and financial strain, it is important for research to focus on aiding adults with ASD and ID.

For individuals with ASD, there is a negative correlation between IQ and the severity and the number of RB exhibited (Bishop, Richler & Lord, 2006; Gabriels, Cuccaro, Hill, Ivers, & Goldson, 2005; Goldman et al., 2009). Thus, an individual with a lower IQ will typically exhibit a higher number of RB. RB can be divided into two broad categories: (1) higher-level behaviours and (2) lower-level behaviours (Turner, 1999). Higher-level behaviours include circumscribed interests, attachment to objects, maintenance of sameness, and repetitive language. Circumscribed interests can range from fixation on details of an environment that an individual may not typically focus on (such as serial numbers) to an obsession with a more common hobby (such as astronomy; Turner, 1999). Insistence on sameness is characterized by difficulties with changes in routines or other adjustments in their environment, compulsions, and rituals (e.g., insists on using the same door; Szatmari et al., 2006; Cuccaro et al., 2003; Richler, Huerta, Bishop & Lord, 2010, Bodfish, Symons, & Lewis, 1999).

Lower-level behaviours encompass stereotyped behaviours and repetitive manipulation of objects (Turner, 1999). Stereotyped behaviours are described as purposeless and repetitive actions and consist of movements such as hand flapping, rocking, spinning objects, and vocalizations (Ravizza, Solomon, Ivry & Carter, 2013; Singer, 2009; Gardenier, MacDonald & Green, 2004). These mannerisms can also be classified as self-stimulating behaviours if the purpose of the movement is to gain sensory feedback (e.g., moves object in front of eyes for visual feedback; Lovaas, Newsom, & Hickman, 1987).

Both higher- and lower-level of RB are related to a decrease in adaptive functioning for people with ASD (Gabriels et al., 2005). Similarly, the stereotypic

behaviours (lower-level) were related to a lower adaptive functioning score for people with ID (Matson, Kiely & Bamburg, 1997). Adaptive functioning includes behaviours that involve performing activities independently such as daily living skills (e.g., brushing one's own teeth, doing laundry, and food preparation), and social and communicative abilities that are age appropriate (Smith, Maenner, Mailick & Seltzer, 2012). In addition, RB may interfere with the ability of people with ASD to learn a new task and perform an already learned task (Koegel & Covert, 1972; Litrownik & Mann, 1971; Ravizza et al., 2013). Thus, it is beneficial to research interventions that reduce the number of RB for people with both ASD and ID.

Interventions attempting to suppress RB have included pharmacological approaches, response blocking, response interruption and redirection, antecedent-based interventions, and sensory integration. However, the results of these interventions are inconclusive in their ability to reduce RB (Ahrens, Lerman, Kodak, Worsdell & Keegan, 2011; Carrasco, Volkmar & Bloch, 2012; Hagopian & Toole, 2009; Hodgetts, Magill-Evans & Misiaszek, 2011). Exercise, another intervention modality, is typically used to improve physical outcomes (i.e., cardiorespiratory fitness and muscular strength), but has also shown to reduce the number of RB exhibited by people with ASD (e.g., Anderson-Hanley, Tureck & Schneiderman, 2011; Bahrami, Movahedi, Marandi & Abedi, 2012; Elliott, Dobbin, Rose & Soper, 1994; Watters & Watters, 1980).

The majority of the successful exercised-based interventions utilized a form of aerobic exercise (e.g., Anderson-Hanley et al., 2011; Kern, Koegel, Dyer, Blew & Fenton, 1982; Rosenthal-Malek &Mitchell, 1997). Aerobic exercise may be beneficial because it can be individually-focused, and people with ASD preferred these activities

over team-oriented activities (Pan & Frey, 2006). Furthermore, in comparison to a milder form of physical activity, a vigorous type of exercise (such as aerobic exercise) may be needed to reduce the number of RB exhibited by individuals with ASD (Kern, Koegel, & Dunlap 1984; Elliot et al., 1994).

The observed benefits of exercise for individuals with ASD have been recognized over short-term and long-term time frames. Reductions in RB have been noted immediately following a single exercise session (i.e., 20 minutes of biking or dancing) and for up to one month following a 14-week intervention (karate-like training program; Anderson-Hanley et al., 2011; Bahrami et al., 2012). Additionally, tracking the number of RB acutely provides information about the participant's immediate response to exercise. However, it is beneficial to track both the acute and the overall changes in RB throughout an exercise intervention as it would provide an accurate representation of the changes in RB. A potential confound for the reduction of RB following exercise is that the participants are fatigued, which would result in a reduction in all behaviours. The effect of fatigue on RB expression has not been studied, and individuals with ASD displayed improvements in academic performance and on measures of executive functioning in addition to a decrease in RB following 20 minutes of aerobic exercise (Anderson-Hanley et al., 2011; Rosenthal-Malek & Mitchell, 1997). Furthermore, individuals with ASD experienced an improvement in completing tasks within a community-based workshop and a decrease in the number of disruptions during employment following 20 minutes of jogging. Participants also experienced a corresponding reduction in RB (Elliott et al., 1994; Rosenthal-Malek & Mitchell, 1997).

These examples suggest that the reductions in RB were not due to fatigue and that engagement in exercise may improve task performance.

Therefore, the purpose of this study was to examine if (1) people with ASD and ID would exhibit fewer RB immediately following an aerobic exercise session, (2) they would show an improved ability to perform tasks immediately following an aerobic exercise session, and (3) they would display a reduction in RB severity after engaging in a number of exercise sessions.

CHAPTER 2: Literature Review

Overview of ASD

ASD is a neurodevelopmental disorder that is characterized by 1) deficits in social and communicative functioning, and 2) engaging in behaviours, interests and activities that are restricted and repetitive in nature (APA, 2013). Social and communicative impairments affect multiple contexts, including deficits in social-emotional reciprocity, non-verbal communication, and developing and maintaining social relationships (APA, 2013). The second characteristic of people with ASD (i.e., behaviours, interests and activities that are restricted and repetitive in nature) includes stereotyped behaviours or repetitive motor movements such as: echolalia, simple motor stereotypies, and the lining up objects. Additionally, the second characteristic includes: insistences on sameness, inflexibility to routines, and highly fixated interests. Furthermore, for people with ASD, behaviours such as excessive smelling and fascination with lights may be due to either hyper- or hypo-sensitivity to sensory stimuli. A diagnosis of ASD is broad and involves varying levels of impairments. For example, previous classifications such as High Functioning Autism, Asperger's Disorder, and Pervasive Developmental Disorder-Not Otherwise Specified, are now encompassed by a diagnosis of ASD (APA, 2013).

The current prevalence of ASD is 1 in 68 children in the United States (CDC, 2016). Furthermore, there has been a reported rise in ASD diagnoses with prevalence rates in Southeastern Ontario rising 13% between 2003 and 2010 (Ouellette-Kuntz et al., 2014; Wing & Potter, 2002). In addition, 31% of people with ASD also have ID (CDC, 2014). ID is classified as having impairments in both intellectual and adaptive functioning, illustrated by commonly having an IQ score approximately two standard

deviations below their typically developing peers (APA, 2013). As a result, they may also have difficulties with judgment, problem solving, and learning.

A diagnosis of ASD is associated with indirect and direct costs (Ganz, 2007). Indirect costs can include a reduced income for family members from decreased work hours or leaving the workforce to take care of a person with ASD (Ganz, 2007). The direct costs can include medical expenses, supported employee services, home and vehicle modifications, and out-of-home placement (Ganz, 2007). Furthermore, adult care takes up a significant portion of the direct cost and is typically five times larger than the costs for behavioural therapies, child/respite care, and special education that occur in childhood (Ganz, 2007). In addition, the majority of medical expenses occur after the age of 21 years (Ganz, 2007). Thus, there is an increased financial burden for families caring for an adult with ASD.

Additionally, the families of individuals with both ASD and ID tend to have an increased financial burden compared to people with ASD or ID alone (Ouyang et al., 2014). Ouyang et al. (2014) found that, in order to take care of a family member with ASD and ID, 46% of caregivers or another family member had to quit working, compared to 25% of people with ASD or ID only. Additionally, 85% of people with ASD and ID were reported to have fair or poor functional abilities in relation to 54% of people with ASD only and 71% of people with ID only. These functional abilities consisted of difficulties with learning, paying attention, speaking, behavioural difficulties, and social problems (Ouyang et al., 2014). Caregivers of those individuals with difficulties in learning and paying attention were more likely to report an increased financial strain (Ouyang et al., 2014). Both compromised functional ability and

difficulties with learning and paying attention further exemplify the extra support required by caregivers and family members to care for a person with both ASD and ID. Therefore, due to the rising prevalence, lifelong impairments, increased complexity with the presence of ID, and the strain on caregivers/family members, it is important to assess potential interventions for adults with ASD and ID.

Repetitive Behaviours

RB are important to target for interventions because they are related to a decrease in adaptive functioning for people with ASD (Gabriels et al., 2005; Matson et al., 1997; Richler et al., 2010; Szatmari et al., 2006). In order to conduct interventions attempting to reduce RB, it is important to know the definition, potential causes, and factors affecting RB. In a seminal article, Kanner (1943) described multiple detailed case studies where behaviours that were repetitive in nature were observed. For example, one individual enjoyed spinning, throwing and organizing objects. Other than these behaviours, the participant showed no interest in engaging in alternative activities, despite encouragement (Kanner, 1943). More recently, the DSM-5 provided an overview of the various kinds of behaviours that are associated with a diagnosis of ASD, and described them as behaviours, interests, and activities that are restricted and repetitive in nature (APA, 2013). **Table 1** provides the different behavioural categories in the DSM-5.

Within the literature there are similarities and differences in the terms used to describe behaviours, interests, and activities that are restricted and repetitive in nature. Turner (1999) used the term repetitive behaviours (RB) which broadly defines a class of mannerisms that are characterized by rigidity, repetition, inappropriateness, and invariance. These behaviours can be further divided into two broad categories: (1)

Table 1

DSM-5 Classifications of behaviours, interests and activities that are restricted and repetitive in nature

Specific Types of Behaviours in People with ASD	Examples
Stereotyped, repetitive motor movements, speech, or use of objects	Lining up objects, echolalia, simple motor stereotypies, idiosyncratic phrases
Insistence on sameness	Patterns of non-verbal and verbal behaviour that are inflexible and adhere to a ritualized routine
Fixed interests that are highly restricted and abnormal in intensity and focus	Strong attachment to unusual objects or perseverative interests
Hyper or hypo response to sensory input Unusual interests in sensory aspects of the environment	Excessive smelling, fascination with lights and indifference to pain

(Adapted from APA, 2013)

higher-level behaviours and (2) lower-level behaviours (Turner, 1999). A similar division of RB was found in more recent research assessing the behavioural items in the Autism Diagnostic Interview-Revised (ADI-R; Cuccaro et al., 2003; Szatmari et al., 2006). The ADI-R divides behaviours into insistence on sameness and repetitive sensory motor behaviours, which are similar to higher-level behaviours and lower-level behaviours, respectively (Cuccaro et al., 2003; Szatmari et al., 2006). Appendix A includes the definition for both types of classifications and terms that describe the types of RB.

Turner (1999) described higher-level behaviours as including circumscribed interests, attachment to objects, maintenance of sameness, and repetitive language. Circumscribed interests can range from fixation on unusual details of an environment (such as serial numbers) to an obsession with a more common hobby (such as astronomy;

Turner, 1999). Similarly, insistence on sameness is characterized by difficulties with changes in routines or other adjustments in their environment, compulsions, and rituals (Cuccaro et al., 2003; Richler et al., 2010; Szatmari et al., 2006). Nonetheless, these behaviours tend to be complex and difficult to assess (Turner, 1999). For example, it is difficult to differentiate the level at which being very interested in a topic (i.e., a hobby) becomes a restricted interest (Turner, 1999). Overall, higher-level behaviours become inflexible, which disrupts other activities (Howlin, 2004).

The second category, lower-level behaviours, encompasses stereotyped behaviours and repetitive manipulation of objects (Turner, 1999). These mannerisms are classified together because of their repetitive nature and are more common in younger children with more severe forms of ASD, and people with ID or brain-based impairments (Leekam, Prior & Uljarevic, 2011; Turner, 1999). Stereotyped behaviours are described as purposeless, repetitive actions, and consist of movements such as hand flapping, rocking, spinning objects, and vocalizations (Gardenier et al., 2004; Ravizza et al., 2013; Singer, 2009). Furthermore, stereotyped behaviours can be subdivided into motor stereotypies, which exclude behaviours such as lining up objects and focuses on behaviours such as rocking (Singer, 2009; Goldman et al., 2009). Compared to higher-level behaviours, lower-level behaviours, specifically stereotyped behaviours, are more frequently researched due to the ability for them to be more readily quantified (Turner, 1999).

Another lower-level behaviour includes self-stimulatory behaviours, which appear similar to stereotyped behaviours because the same actions are used to describe both types, such as rocking and spinning (Gardenier et al., 2004; Lovaas et al., 1987).

However, the proposed cause for self-stimulating behaviours is sensory feedback whereas stereotyped behaviours are defined as purposeless (Lovaas et al., 1987). The more recent classification of lower-level behaviours, repetitive sensory motor behaviours, integrates both stereotyped and self-stimulatory behaviours by stating that apart from self-stimulation these behaviours have no apparent purpose (Cuccaro et al., 2003). Thus, there appears to be two main types of RB and there are various terms used within each type, which overlap in definition and the examples used to describe RB.

Although there are many different types of RB, they are not studied to the same extent as communicative and social impairments despite the burden and limitations RB impose on the families and individuals with ASD (Leekam et al., 2011). Thus, researching interventions used to reduce these RB would be beneficial to people with ASD and ID, and their caregivers.

Causes of Repetitive Behaviours

There are various proposed theories concerning the cause of RB, including environmental deprivation, sensory abnormalities, operant behaviours, neurological abnormalities, and impairments in executive functioning. Though these behaviours are suggested to be a part of typical development in early childhood, people with ASD maintain these behaviours into adulthood (Leekam et al., 2011). For example, Baranek (1999) assessed RB in infants with ASD as well as typically developed infants. The results showed that although there were significant sensory-motor impairments when RB were examined, there was no significant difference in RB between infants with ASD and individuals with typical development (Baranek, 1999). When children of typical development and children with ASD were assessed on the number of stereotyped

behaviours exhibited at two years of age, children with ASD exhibited a higher number of such behaviours (MacDonald et al., 2007). This difference was more prominent when children were assessed at ages three and four years (MacDonald et al., 2007). These examples support the idea that people with ASD, as well as those who are typically developing, exhibit stereotyped behaviours during infancy. However, with an increasing age, stereotyped behaviours continue to be displayed by people with ASD.

One reason for the persistence of stereotyped behaviours among individuals with ASD could be due to extreme social withdrawal early in childhood, which restricts them from the environmental interaction required to facilitate typical development (Leekam et al., 2011). In support of this theory, a study examining extreme environmental deprivation in children from orphanages in Romania found that around 11% of these individuals were termed "Quasi-Autism" because they displayed similar characteristics of people with ASD, including circumscribed interests and stereotypic behaviours (Rutter et al., 2007). This suggests that the extrinsic restrictions that were placed on these orphans resulted in autistic-like behaviours, whereas intrinsic impairments prevent individuals with ASD from interacting with their environment, thus creating self-induced environmental deprivation (Rutter et al., 2007). These intrinsic impairments may relate to the extreme social withdrawal associated with ASD or the sensory abnormalities that are related to RB.

The majority of individuals with ASD have at least one sensory abnormality, the most common abnormalities being over-reactivity to sound and hypo-sensitivity to pain (Klintwall et al., 2011). Such sensory abnormalities, as well as RB, are more prevalent in people with ASD compared to people with a non-ASD developmental disabilities, and

are positively correlated with the total number of RB exhibited (Boyd et al., 2010; Chen, Rodgers & McConachie, 2009). Auditory, visual, and tactile sensitivity were related to the intensity and frequency of RB, such as compulsions, stereotypic behaviours, and ritualistic/sameness behaviours (Boyd et al., 2010; Chen et al., 2009). However, sensory seeking behaviours were related only to ritualistic/sameness behaviours, whereas hypo-responsiveness to sensory stimuli was not related to any abnormal behaviours (Boyd et al., 2010). Although these results suggest a significant connection between sensory abnormalities and RB, not all studies found this relationship (Hattier, Matson, MacMillan & Williams, 2012; Klintwall et al., 2011). Nonetheless, sensory abnormalities may be a factor in the development and maintenance of maladaptive behaviours in people with ASD.

The maintenance of these behaviours may be explained by the operant model proposed by Lovaas et al. (1987), which states that the perceptual feedback derived from self-stimulating behaviours is desirable, and this shapes the existing self-stimulatory behaviours (Lovaas et al., 1987). For example, if an individual is fascinated with the visual stimuli provided by moving a string, they will move it in different directions in order to discover a movement that provides the most desirable stimuli. That movement is then rehearsed until the individual can perform the exact movement consecutively (Lovaas et al., 1987). Although, this may explain the maintenance of these behaviours, sensory abnormalities do not fully explain the development of RB (Turner, 1999).

The development of RB may be due to the differences in the brain structure of people with ASD compared to individuals with typical development (Goldman, O'Brien, Filipek, Rapin & Herbert, 2013; Rojas et al., 2006). For example, there is a decrease in

gray matter volume in the cerebellum, and an increase in gray matter volume in the right fusiform gyrus, the caudate nuclei, and the left hippocampus (Rojas et al., 2006). Some of these structural differences have been correlated to either higher-level or lower-level behaviours (Langen et al., 2009; Rojas et al., 2006; Wolff, Hazlett, Lightbody, Reiss & Piven, 2013). Although, the literature provides differing results in terms of which brain regions are involved in the development of RB (Langen et al., 2009; Rojas et al., 2006; Wolff et al., 2013). In particular, increases in the volume of the caudate nuclei have been correlated to an increase in repetitive, ritualistic, and compulsive behaviours; conversely, Langen et al. (2009) found a negative correlation between insistence on sameness behaviours and the volume of the caudate nuclei (Rojas et al., 2006; Wolff et al., 2013). Using diffusion tensor imaging and functional magnetic resonance imaging (fMRI), Thakkar et al. (2008) assessed the white matter tracks in the anterior cingulate cortex (ACC) in people with ASD and typical developing individuals. The results indicated that for people with ASD, there was a reduction in the amount of white matter within the ACC and elevated activation patterns in the rostral ACC, which were both related to the presence of RB. Moreover, during the fMRI, a response monitoring task was implemented and the results suggested that people with ASD displayed a decreased ability to differentiate between response outcomes (Thakkar et al., 2008). Thus, the authors suggested that the ACC may contribute to the presence of RB through a lack of response monitoring (Thakkar et al., 2008). Overall, there are many regions that have different growth patterns in people with ASD compared to their typically developing peers and with some regions possibly affecting the development of restricted and RB.

In addition, deficits in brain processing, such as executive functioning, may contribute to the presentation of RB in people with ASD. Executive functioning can include cognitive processes such as planning, mental flexibility, response inhibition, and working memory (LeMonda, Holtzer & Goldman, 2012; Lopez, Lincoln, Ozonoff & Lai, 2005). A study comparing 17 adults with ASD to 17 individuals with typical development controls examined whether a deficit in executive functioning would be associated with RB (Lopez et al., 2005). People with ASD were found to have impairments in planning and cognitive flexibility, although they did not differ from controls in response inhibition and working memory (Lopez et al., 2005). However, cognitive flexibility, response inhibition, and working memory were positively correlated to restricted and RB (Lopez et al., 2005). This suggests that strengths and weaknesses in executive functioning is related to the development of restricted and RB (Lopez et al., 2005). Taken together, the literature suggests that the development of RB may be a result of a combination between genetics and the environment, as the majority of research on RB tends to be assessed by either a neurobiological perspective or an operant model approach (Lanovaz, 2011; Lewis & Kim, 2009). Thus, the factors that may cause restricted or RB need to be integrated in order to gain a full understanding of their origin.

Factors that Affect the Appearance of Repetitive Behaviours

There are many factors that can influence the appearance of RB such as anxiety, intrinsic and extrinsic motivation, context, and level of arousal. Rodgers, Glod, Connolly and McConachie (2012) assessed the level of anxiety of people with ASD and divided them into two groups, ‘anxious’ and ‘non-anxious’. The level of anxiety was then compared to insistence on sameness/circumscribed interest behaviours and sensory motor

RB. They found that the anxious group had a higher score for both types of behaviours compared to the non-anxious group. Specifically, insistence on sameness or circumscribed interest behaviours are related to measurements of separation anxiety and fear of physical injury (Rodgers et al., 2012). Additionally, those with a high level of anxiety are more likely in people with both ASD and ID compared to ID alone (Joosten, Bundy & Einfeild, 2009). Furthermore, Joosten et al. (2009) found that for people with ASD and ID, the intrinsic motivation for engaging in RB was related to anxiety rather than for sensory seeking purposes. In addition, they found that the extrinsic motivation for RB can be divided into behaviours that are displayed in order to gain an object, gain attention, or escape items (i.e., avoiding activities or people). Of these behaviours, people with ASD and ID were extrinsically motivated to engage in RB to escape or gain a tangible object (Joosten et al., 2009). Moreover, the type of motivation for RB of individuals with ASD and ID was assessed in multiple contexts: free time, transitioning from one activity to another, and when engaging in a task (Joosten, Bundy & Einfeld, 2012). During free time, the intrinsic motivation was sensory seeking and the extrinsic motivation was to gain attention or a tangible object. When participants were transitioning from one activity to another the intrinsic motivation to engage in RB was to reduce anxiety and the extrinsic motivation was to escape from the situation and to gain a tangible object. Whereas, when participants engaged in a task, there was no specific type of intrinsic or extrinsic motivation that would specifically influence the number of RB (Joosten et al., 2012). Thus, both intrinsic and extrinsic motivation may alter the number of RB exhibited in conjunction with the context an individual with ASD is in (Joosten et al., 2012).

Similar to anxiety, a lack of arousal may affect the number of RB exhibited (Lydon, Healy & Dwyer, 2013). When heart rate was measured before, during, and after the display of RB there was an increase in heart rate following the behaviours. The authors suggested that an increased level of arousal was desirable for people with ASD, and the RB were used to attain this (Lydon et al., 2013). Although this contradicts the idea that stereotyped behaviours are used to reduce anxiety, this may exemplify the sensory seeking behaviours that are more likely to occur during the participant's free time (Lydon et al., 2013; Joosten et al., 2012). Therefore, certain factors that affect the number of RB can be influenced by anxiety, various types of motivation, the context an individual with ASD is in, and a lack of arousal.

Other factors that alter the number of RB include the severity of ASD, sex, IQ, and the age of the individual. Severity of ASD has been positively correlated to the number of challenging behaviours exhibited, including RB (Matson, Wilkins & Macken, 2008). Within the 90% of people with ASD who exhibit challenging behaviours, RB occurred more frequently than all other behaviours and were specifically associated with the severity of ASD (Jang, Dixon, Tarbox & Granpeesheh, 2011; Matson et al., 2008). Although females tend to display a lower number of RB, this difference diminishes as the severity of ASD lessens (Hattier, Matson, Tureck & Horovitz, 2011; Holtmann, Bölte & Poustka, 2007). Thus, the severity of ASD itself and an individual's sex can be factors that alter the number of RB displayed by people with ASD.

For an individual with ASD, IQ is another factor that may be related to the severity and the number of RB exhibited, where there is a negative correlation between IQ and the severity and the number of RB (Bishop et al., 2006; Gabriels et al., 2005;

Goldman et al., 2009). However, this applies only to lower-level behaviours (such as body-rocking and hand mannerisms); high-level behaviours (such as restricted interests) have been reported to have either no relationship with cognitive functioning, or to be related to a high IQ (Bishop et al., 2006; Richler et al., 2010; Singer, 2009). Additionally, the association between IQ and RB becomes more pronounced as people with ASD age from early to late childhood (Bishop et al., 2006). This may indicate that as people with ASD develop, IQ may have a greater influence on number of RB displayed. Overall, IQ is considered to be a contributing factor to the presentation of RB in people with ASD.

Another contributing factor is the age of the person with ASD. As reported earlier, typically developing infants display a similar number of RB as infants with ASD (Baranek, 1999). However, from ages two to four years, children of typical development show a reduction in the number of RB exhibited, whereas individuals with ASD continue to exhibit the same number of RB (MacDonald et al., 2007). After this age, there is a progressive decrease in the number of RB for people with ASD (Richler et al., 2010; Bishop et al., 2006; Murphy et al., 2005). A longitudinal study assessed the RB in children with ASD and children with a non-ASD developmental disorder at ages three, five and nine (Richler et al., 2010). The results indicated a negative correlation between the number of RB and age. Thus, RB decreased from age three to nine, however the rate of decrease slowed as individuals aged. In contrast, there was a positive correlation with age and insistence on sameness behaviours. As individuals with ASD aged, the rate of increase in insistence on sameness behaviours slowed (Richler et al., 2010). Similarly, Bishop et al. (2006) reported a positive correlation with age and self-injury,

compulsions/rituals and sensitivity to noise along with insistence on sameness behaviours, and a negative correlation was found between age and repetitive use of objects and unusual sensory interests. Even though individuals with ASD showed a reduction in the number of RB, the majority of them still exhibited a high number of RB at age nine in comparison to people with a non-ASD developmental disorder (Richler et al., 2010). Furthermore, when RB were examined between young adults and older adults with ASD and ID, there was no significant difference (Hattier et al., 2011). Thus, these results suggest that both higher- and lower-level behaviours are sustained in adulthood (Hattier et al., 2011). From the research described above, it could be suggested that RB are more severe in early in childhood, decreased during youth and adolescence, until a plateau is reached in adulthood. Therefore, the age of an individual with ASD is a factor that can affect the number of RB displayed, until the individual reaches adulthood where the levels of RB are maintained. In summary, RB can be altered by numerous factors such as anxiety, intrinsic and extrinsic motivation, context, arousal, severity of ASD, gender, IQ, and the age of the individual with ASD.

Assessing Repetitive Behaviours

There are various methods used for assessing the number, duration or severity of RB. One method is the RBS-R, which is a 43-item questionnaire that includes six subcategories: stereotyped behaviour, self-injurious behaviour, compulsive behaviour, ritualistic behaviour, sameness behaviour, and restricted behaviour (Bodfish. et al., 1999; Bodfish et al., 2000; Lam & Aman, 2006). Each question follows a 0 to 3 rating scale, where 0 represents “behaviour does not occur” and 3 represents “behaviour occurs and is a severe problem” (Lam & Aman, 2006). This scale is typically administered to a parent

or care-giver of the individual, and can be used to assess the outcomes of treatments in adults with ASD (Honey, Rodgers & McConachie, 2012; Lam & Aman, 2006). The inter-rater reliability of the RBS-R was tested by mailing questionnaires to pairs of caregivers of individuals with ASD (Lam & Aman, 2006). Fair to good inter-rater reliability was determined by calculating the ICC scores for each subscale, which ranged from 0.57 (compulsive behaviour) to 0.73 (stereotypic behaviour) and a mean of 0.67 (Lam & Aman, 2006). Within the same study, an exploratory factor analysis was conducted on a separate group of 307 questionnaires to determine if the questions loaded better within different subcategories. Questions were placed into a certain subcategory if they loaded higher on that category compared to others. From this analysis, a four- or five-factor solution could be utilized, which may be more valid than the original six subcategories. However, the five-factor solution included the subcategory "restricted interests", which was thought to have clinical significance. Adjustments made to the subcategories include combining ritualistic behaviour and sameness behaviours and changing how several of the questions were categorized (Lam & Aman, 2006). To validate the five-factor model, Lam and Aman (2006) calculated item-total correlations, which resulted in all of the questions correlating most highly with their respective subcategory. The mean average correlation for each of the category categories were: Ritualistic/ Sameness: 0.65, Self-injurious behaviour: 0.58, Stereotypic Behaviour: 0.57, Compulsive Behaviour: 0.54, and Restricted Interests: 0.61 (Lam & Aman, 2006). Internal Consistency was high with an average Cronbach's alpha of 0.83 and a range from 0.78 to 0.91 (Lam & Aman, 2006). Furthermore, the 'total score' on the five-factor scoring supplement was significantly correlated to the Global Severity Score, where RB

were rated from one to 100 on how problematic they were (0.70, $p < 0.001$; Lam & Aman, 2006). Recent research has implemented the RBS-R five-factor solution to compare RB to other features such as executive functioning or sensory processing (Boyd, McBee, Holtzclaw, Baranek, Bodfish, 2009; Dichter et al., 2010). The original (six-factor) RBS-R has been used to assess the effectiveness of an intervention on reducing RB (Baruth et al., 2010; Chugani et al., 2016; Malow et al., 2012; Sokhadze, El-Baz, Sears, Opris & Casanove, 2014).

Other assessment scales include: the Aberrant Behaviour Checklist (ABC), the Autism Diagnostic Interview-Revised (ADI-R), and the Repetitive Behaviour Questionnaire/ Interview. However, unlike the RBS-R, the ABC scale does not directly or specifically assess multiple forms of RB that are exhibited by individuals with ASD. The ABC only measures stereotypic behaviour, in conjunction with hyperactivity, lethargy, irritability, and inappropriate speech (Aman & Singh, 1985). Additionally, a diagnostic scale, such as the ADI-R, is intended to discriminate between individuals who display RB from those who do not, rather than tracking changes in RB over time (Honey et al., 2012). In contrast, the Repetitive Behaviour Questionnaire/Interview is a scale designed to examine RB. However, a limitation to this scale is the combined scoring option of behaviours that occur "never/rarely", which makes it impossible to distinguish between behaviours that are never present and those that only occur occasionally (Honey et al., 2012). Since the RBS-R can assess many forms of RB, indicate the absence of behaviour, and has been used to track changes of RB severity over time, it is the most appropriate measure for researchers assessing specific RB over the course of an intervention.

There are some limitations to the RBS-R, such as only three questions were loaded on the restricted interests subcategory in the five-factor solution (Lam & Aman, 2006). Additionally, echolalia (a form of repetitive speech; APA, 2013) is indirectly assessed by a question in the ritualistic/sameness subcategory, but is not directly assessed (Lam & Aman, 2006). The test re-test reliability has only been assessed in the six-factor model and not the five-factor solution (Honey et al., 2012). Furthermore, assessing RB within the same day may be difficult with the RBS-R. This may lead researchers to implement other techniques in order to assess the changes in RB within the same day.

To assess changes in RB over shorter time periods (i.e., within the same day), prior research has used various forms of interval sampling methods. Interval sampling methods include dividing the observation time into small intervals (e.g., 10 second intervals) and indicating whether or not the participant engaged in RB within each interval (Bachman & Fuqua, 1983; Celiberti, Bobo, Kelly, Harris & Handleman, 1997; Powers, Thibadeau, & Rose, 1992). Gardenier et al. (2004) describe two types of observation methods: partial-interval recording and momentary time sampling. Partial-interval recording (PIR) is when the minute is divided into 10-second intervals, and if a repetitive behaviour occurs within any of those 10 seconds, then it is recorded as if the repetitive behaviour occurred for the entire 10 seconds. Momentary time sampling (MTS) assesses whether a repetitive behaviour has occurred within one-second intervals every 10, 20 or 30 seconds. For example, if a 30-second interval was chosen, every 30th second is the only time where the researcher indicates whether a repetitive behaviour has occurred. For each interval it was noted whether or not RB occurred, but specific RB were not identified.

Both PIR and MTS methods were compared to the actual duration of time a person engaged in RB, which was determined by assessing the entirety of the video (Gardenier et al., 2004). Depending on the time interval used (10, 20, or 30 seconds), the PIR overestimated and MTS methods both over- and underestimated how much an individual engaged in RB within a certain amount of time (Gardenier et al., 2004). Thus, for assessing observation periods that are short in length, it may be beneficial to examine every second, whereas a longer observation periods may require a time sampling method.

Task Performance and How Repetitive Behaviours Impair Functioning

The causes and the factors that affect RB are important to understand because these behaviours are related to a decrease in adaptive functioning for people with ASD (Gabriels et al., 2005; Matson et al., 1997; Richler et al., 2010; Szatmari et al., 2006). Adaptive functioning includes behaviours that involve performing activities independently such as daily living skills (e.g., brushing one's own teeth, doing laundry and, preparing food), and social and communicative abilities that are age appropriate (Smith, et al., 2012). People with ASD improve in adaptive functioning between adolescence and their early 20s, however, this improvement plateaus and declines around 30 years of age (Smith et al., 2012). Furthermore, people with ASD and ID, compared to people with ASD but without ID, will have a greater impairment in adaptive functioning and will have a slower rate of improvement in such skills as they age (Gabriels et al., 2005; Smith et al., 2012). Thus, people with both ASD and ID may have persistent impairments in adaptive functioning.

These impairments in adaptive functioning may be in part due to RB interfering with both learning and performing a familiar task. Early descriptions of RB explained

that when individuals with ASD were engaging in RB, there was an increased difficulty in teaching new skills as attention was solely encompassed by the RB (Kanner, 1943; Lovaas et al., 1987). Koegel and Covert (1972) had individuals with ASD learn a discrimination task in which they were to press a bar following a specific sound. The reward for a correct response was candy and each session took 10 minutes to complete. The individuals that exhibited RB showed impairments in learning the task. Although, when researchers verbally discouraged participants from engaging in RB (i.e., sharply saying no) or, in some cases, slapped the participant's hands to suppress RB, they were able to learn and perform the task correctly. Thus, because they were able to respond appropriately following suppression of RB, a lack of response from people with ASD was a result of RB interfering with the learning of the task rather than being due to motor impairments affecting their ability to respond (Koegel & Covert, 1972). Furthermore, when assessing performance on a counting task people who exhibited RB displayed a lower level of performance (Morrison & Rosales-Ruiz, 1997). Additionally, when the number of RB were decreased, there was an improvement in academic performance (Rosenthal-Malek & Mitchell, 1997).

RB may interfere with the ability to perform a task even once it has been learned. Lovaas, Litrownik & Mann (1971) assessed the time it took for participants to respond to the correct sound. A correct response included participants standing up from a chair, walking to a dispenser to retrieve candy, followed by returning to a seated position in the chair. The participants that engaged in RB took up to 20 seconds longer to respond compared to those who did not display RB. Furthermore, when individuals with ASD were asked to perform a rhythmic-tapping task, the stereotypic behaviour score (rated by

a parent on the RBS-R) was correlated to a reduced accuracy in tapping performance (Ravizza et al., 2013). Thus, difficulty in learning and performing a task may be the reason for the reduced ability to engage in activities of daily living, such as brushing one's teeth. Therefore, reducing RB in people with ASD, in most cases, is warranted due to the difficulties they may pose.

A Measure of Task Performance

A measure that includes easily accomplished tasks and mimics movements involved in activities of daily living is necessary in order to determine if reducing RB results in an improved task performance. The JHFT is a measure of hand function and the subtests are related to various activities of daily living (Jebsen, Taylor, Trieshmann, Trotter & Howard, 1969; Lynch & Bridle, 1989). The JHFT includes seven subtests: writing, turning over cards, picking up small common objects, simulated feeding, stacking checkers, picking up large light objects, and picking up large heavy objects. This test can be applied to a clinical setting where improvements in performance can be tracked (Jebsen et al., 1969).

The reliability of the JHFT was initially tested in 26 patients with stable hand disabilities (Jebsen et al., 1969). The results indicated Pearson correlation coefficients ranging from 0.6 to 0.99 (Jebsen et al., 1969), suggesting that each subtest was reliable over time. Additionally, practice effects were assessed and the differences between trials did not reach statistical significance, suggesting that there was no practice effect (Jebsen et al., 1969). The inter-rater reliability for the JHFT was determined by having two researchers simultaneously score five individuals 60 years of age or older (ICC = 0.82 to 1.00; Hackel, Wolfe, Bang & Canfield, 1992). A current analysis of the JHFT test-retest

reliability was conducted among adults with ASD and ID (Carr, et al., 2015). Within this study, four of the seven subtests were evaluated (turning over cards, picking up small common objects, stacking checkers, and picking up large heavy objects) and were found to have high test-retest reliability (ICC = 0.90 to 0.95). The results suggested high test-retest reliability for the majority of the JHFT subtests when administered to adults (i.e., mean of 35.5 years of age, range 20-61 years) with ASD and ID (Carr, et al., 2015).

The validity of the JHFT's ability to predict activities of daily living (ADL) was assessed by comparing the scores of the JHFT to another test of ADL, the Klein-Bell scale (Klein & Bell, 1982), on 18 adults recovering from a spinal cord injury (Lynch & Bridle, 1989). A moderate correlation ($r = -0.635$, $p < 0.01$) was found between the JHFT and the Klein-Bell scale. The authors indicated that the JHFT, to some degree, can predict functional hand use in ADL (Lynch & Bridle, 1989). Although the JHFT is not intended to directly predict abilities specific to ADL, the tasks are similar. Therefore, the JHFT may be a valuable tool in tracking variations in an individual's ability to perform tasks similar to ADL.

Interventions used to Treat Repetitive Behaviours

Since RB may impede the daily functioning of individuals with ASD, many proposed treatments exist with the goal of reducing the occurrence of such behaviours. Some of these treatments include pharmacological approaches; response blocking; response interruption and redirection; antecedent-based interventions; and sensory integration. For pharmacological treatments, selective serotonin reuptake inhibitors (SSRI) have been used to reduce RB (Hollander et al., 2004). Hollander et al. (2004) administered liquid fluoxetine, an SSRI, to children and adolescents with ASD for eight

weeks, which was compared to an eight-week placebo phase. They found that RB were significantly reduced compared to the placebo condition. Although other forms of SSRI administered to people with ASD may not have the same results, this finding was not reproduced in other studies that administered SSRI to participants. King et al. (2009) used liquid citalopram, a different form of a SSRI, in a 12-week trial on children and adolescents with ASD. The results indicated that there were no significant decreases in RB compared to the placebo condition. Furthermore, there was a 12% drop out rate due to side effects such as impulsiveness, decreased concentration, insomnia, and hyperactivity. Additionally, some participants experienced nightmares, and two participants experienced seizures (King et al., 2009). Moreover, Carrasco et al. (2012) suggested that there is an overrepresentation of studies being published that show a positive effect from administration of SSRI compared to unpublished studies that do not show a significant effect, a reflection of publication bias. Currently, the results of pharmacological treatments on RB for individuals with ASD are inconclusive.

As an alternative to pharmacological treatments, therapists may try to reduce RB by physically preventing individuals with ASD from performing the behaviour, which is called response blocking (Hagopian & Toole, 2009). For instance, the participant in this study engaged in 'body tensing' and the therapist would prevent her from laying down to engage in that behaviour. Although this technique can reduce the number of RB, it may be associated with an increase in aggression (Hagopian & Toole, 2009). An alternative strategy would be to give the individual an activity to perform in order to divert their attention away from RB. Response interruption and redirection (RIRD), a form of overcorrection, reduces RB by focusing the individual's attention on performing a task

related to that behaviour (Ahrens et al., 2011). For example, if the individual is exhibiting a vocal based RB, a verbal task would be used, or, if they exhibited a motor RB a motor task would be used. When examined for its effectiveness, both motor and vocal RB were reduced by RIRD (Ahrens et al., 2011). Another technique to reduce RB is antecedent-based treatment, which involves displaying one of two cards representing (1) that engaging in RB was not acceptable, or (2) that it was acceptable (Conroy, Asmus, Sellers, & Ladwig, 2005). When the card depicting that RB were not acceptable was shown, there was a decrease in the number of RB exhibited. However, a long-term reduction in RB was not documented.

Another suggested treatment for reducing RB is sensory integration therapy. Functional assessments can be performed to determine if sensory input is the primary reason for the RB (Sniezyk & Zane, 2014). Sniezyk and Zane (2014) had their participants assessed by their occupational therapist, who suggested that the participants were over stimulated and thus engaged in RB to calm themselves. The participants engaged in individualized activities that were meant to induce calming effects, such as a swing, and RB were measured before, during, and after treatment. The results indicated that for some of the participants there was a decrease in RB. However, the authors concluded that since there was a persistent decrease in RB following the removal of treatment, the decrease was not attributed to the sensory integration treatment (Sniezyk & Zane, 2014). Another example of sensory integration is the use of a weighted vest. Hodgetts et al. (2011) studied the effectiveness of a weighted vest on children with ASD and found that it did not decrease the number of RB exhibited. Although sensory

integration therapy seems promising due to its relation to some of the theoretical causes of RB, it did not seem to yield beneficial results in these studies.

Thus, the results regarding the treatments or interventions for reducing RB are inconclusive. Excluding the pharmacological treatments, therapies designed to reduce the presence of RB are typically targeted to younger individuals, and often exclude individuals with both ASD and ID (Ahrens et al., 2011; Conroy et al., 2005; Sniezyk & Zane, 2014). Therefore, it is important to examine different types of alternative treatments in order to reduce RB among adults diagnosed with both ASD and an ID.

Exercise as an Intervention

Another intervention, which is typically used to improve physical outcomes for individuals with ASD, is exercise. Many individuals with ASD have motor impairments, which can be considered a core characteristic of this disorder (Bhat, Landa & Galloway, 2011; Fournier, Hass, Naik, Lodha & Cauraugh, 2010; Ming, Brimacombe & Wagner 2007). These motor impairments can include hypotonia, apraxia, toe-walking, delayed gross and fine motor milestones, and reduced ankle mobility (Bhat et al., 2011; Ming et al., 2007). Additionally, individuals with ASD are at risk for health problems due to inactivity, similar to people without disability who are inactive (Fournier et al., 2010). Furthermore, people with ASD who have engaged in an exercise program have shown physical benefits such as cardiorespiratory fitness and muscular strength (Magnusson, Cobham & McLeod, 2012; Lochbaum & Crews 2003). Thus, exercise can be beneficial to the physical health of individuals with ASD.

Although exercise is primarily used to improve physical outcomes, it can also result in cognitive benefits (Davis et al., 2011). A study examining functional MRI scans

and measures of executive functioning among sedentary and overweight children found improvements in executive functioning and mathematical achievement, as well as increased prefrontal cortex activation following participation in an exercise program (Davis et al., 2011). Furthermore, Colcombe et al. (2006) assigned sedentary adults (60-70 years of age) to either an aerobic exercise condition or a stretching condition. A high resolution structural MRI was used to examine the amount of grey and white matter the individual had before and after participating in their exercise condition. After a six-month program, there was an increase in both grey and white matter in the individuals who were in the aerobic exercise condition. Specifically, the largest increases were in the anterior white matter tracks and areas in the frontal lobes that are implicated in attention control and memory (Colcombe et al., 2006). Thus, using exercise as an intervention can provide both physical and cognitive benefits.

Exercise has also been used as an intervention to reduce challenging behaviours in various types of diagnoses. Cannella-Malone, Tullis and Kazee (2011) implemented an exercise routine for children with a developmental disability and an emotional disorder. The children that participated in this study displayed challenging behaviours such as throwing objects, aggression, and yelling. The exercise routine included two, 20-minute exercise sessions, one in the morning and one after lunch. Between these 20-minute exercise sessions the participants engaged in five-minute exercise breaks every hour until the end of their school day. The number of exercise days each individual participated in varied between 22 and 32 days. The challenging behaviours decreased following the start of the intervention and remained low throughout the course of the intervention (Cannella-Malone et al., 2011).

Similarly, a 45-minute dance class was implemented twice a week to reduce inappropriate behaviours such as out of context vocalizations, off-task behaviours, and repetitive movements among people with ID (Bachman & Fuqua, 1983; Bachman & Sluyter, 1988). Results suggested that the more the participants exercised, the more the inappropriate behaviours were reduced throughout the day (Bachman & Fuqua, 1983). This concept is further supported by a case study which reported a decrease in body-rocking for a person with ID during participation in a walking /jogging program (Ellis, Maclean & Gazdag, 1989). Moreover, Prupas and Reid (2001) had two individuals with ASD-like characteristics and two individuals with both ASD and Fragile X syndrome engage in four exercise days, which resulted in a decrease in RB following the days that included ten minutes of walking or jogging. There was a further decrease in RB when the participants engaged in multiple ten-minute exercise sessions throughout the day (Prupas & Reid, 2001). Thus, challenging behaviours, as well as RB, can be reduced in various special populations including people with co-diagnosis of ASD.

Exercise interventions for those diagnosed with ASD have been shown to reduce the number of RB exhibited (Anderson-Hanley et al., 2011; Bahrami et al., 2012; Celiberti et al., 1997; Elliott et al., 1994; Kern et al., 1984; Kern et al., 1982; Levinson & Reid, 1993; Powers et al., 1992; Rosenthal-Malek &Mitchell, 1997; Watters & Watters, 1980; Yilmaz, Yanardag, Birkan & Bumin, 2004). A summary of studies examining the effects of exercise on RB is provided in Appendix B. Within the studies that presented a percent reduction, Watters and Watters (1980) and Elliot et al. (1994) reported the largest decreases in RB for people with ASD. Specifically, Watters and Watters (1980) found a 32% reduction in RB, and Elliott et al. (1994) reported a 57% decrease in maladaptive

behaviours and a 65% reduction in RB following their exercise interventions (i.e., eight to 10 minutes of jogging for 11 sessions, and 20 minutes of jogging for five sessions, respectively). However, these studies, as well as others, varied in the duration of the time the participant engaged in exercise, the type of exercise implemented, and the total number of sessions within the study.

The majority of studies outlined in Appendix B had participants engage in 15 to 20 minutes of exercise, however the duration ranged from six to 90 minutes (Anderson-Hanley et al., 2011; Bahrami et al., 2012; Celiberti et al., 1997; Oriel, George, Peckus & Semon, 2011; Kern et al., 1984; Kern et al., 1982; Levinson & Reid, 1993; Rosenthal-Malek & Mitchell, 1997; Watters & Watters, 1980). Although the durations differed, significant results may be due to the level of exercise intensity. Kern et al., (1984) had participants with high levels of RB engage in either mild physical activity (ball playing) or a more vigorous type of exercise (jogging). They found that there was a reduction in stereotyped behaviours after jogging and no change after ball playing. This suggests that there needs to be a certain level of intensity in physical activity to elicit reductions in stereotyped behaviours (Elliot et al., 1994; Kern et al., 1984). In relation to the duration of exercise, it may be beneficial to have short bouts of exercise at a high intensity.

While most exercise interventions seeking to reduce RB among individuals with ASD rely on physical activity in the form of walking or jogging, recent studies have begun to implement unique alternatives. For example, Yilmaz et al. (2004) reported a decrease in RB in a nine year old with ASD who engaged in a swimming education program three times a week for ten weeks. Another intervention successfully reduced RB for a child diagnosed with both ASD and ID through engagement in ten-minute roller-

skating sessions (Powers et al., 1992). Similarly, decreases in RB have been reported from implementing kata training, which is a form of karate, for 15 children with ASD (Bahrami et al., 2012). Anderson-Hanley et al. (2011) had participants either pedal on a recumbent bike that had a video game attached (i.e., Dragon Chase ®), or play Dance Dance Revolution ®, which is a video game that requires the player to perform timed movements. Both forms of exercise were performed once and resulted in reductions in RB (Anderson-Hanley et al., 2011). In addition, one study that assessed RB before and after five sessions of general motor training, one session of a non-exercise, and five sessions of a vigorous aerobic training. The results suggested that reduction in RB only occurred after vigorous aerobic training (Elliott et al., 1994). Overall, most of the interventions that were successful appeared to use a form of aerobic exercise (Anderson-Hanley et al., 2011; Celiberti et al., 1997; Elliott et al., 1994; Kern et al., 1984; Kern et al., 1982; Levinson & Reid, 1993; Powers et al., 1992; Rosenthal-Malek &Mitchell, 1997; Watters & Watters, 1980; Yilmaz et al., 2004). The use of aerobic exercise is further supported by a study that compared engagement in a non-exercise condition, a vigorous aerobic exercise condition, and a general motor training condition which consisted of lifting weights and walking on a treadmill (Elliot et al., 1994). RB were tracked before and after engagement in each condition, and only after the vigorous aerobic condition were RB reduced (Elliot et al., 1994). This suggests that exercise needs to be both aerobic and have a vigorous intensity level.

Additionally, most of the interventions had participants engage in an individualized activity instead of a team-based activity (Anderson-Hanley et al., 2011; Celiberti et al., 1997; Elliott et al., 1994; Kern et al., 1984; Kern et al., 1982; Levinson &

Reid, 1993; Powers et al., 1992; Rosenthal-Malek & Mitchell, 1997; Watters & Watters, 1980; Yilmaz et al., 2004). Individuals with ASD reportedly prefer individually focused activities instead of team-oriented activities (Pan & Frey 2006), such as running, swimming, or martial arts. Although some of these activities occur in a group setting, they are not a team-oriented activity. Such activities may be more stressful due to the increased pressure to understand social cues and react quickly. Thus, individual activities are beneficial to promote physical activity due to the reduced number of social demands (Pan & Frey 2006). In addition, these interventions are beneficial because they do not require a large number of individuals to run the program or participate, and these activities can be utilized throughout adulthood (Pan & Frey 2006). Thus, available evidence suggests that the best exercise interventions for people with ASD are vigorous in intensity, aerobic, and individually focused.

In addition to the duration and the type of exercise, these studies differed on the number of weeks or sessions in which each participant engaged. This ranged from participating in only one session, to a program that had participants engage in exercise four days a week for a total of 14 weeks (Anderson-Hanley et al., 2011; Bahrami et al., 2012). The studies that had only one exercise session were more likely to examine the acute effects of exercise on RB whereas the studies that had a larger number of intervention days assessed the long-term effects. During a 40-minute observation period post-exercise, Celiberti et al. (1997) found that the largest decrease in RB occurred in the first ten minutes following the exercise intervention. After the initial ten minutes, there was a slight increase in RB followed by a stable level of RB that remained lower than pre-exercise levels. Conversely, Levinson and Reid (1993) found increases in the

number of RB to baseline or slightly above baseline at 90 minutes following exercise. However, the authors attributed the increase in RB to the time of day, which was at the beginning of lunch-time when participants may have been excited (Levinson & Reid, 1993). Tracking the number of RB acutely may provide information about the participant's immediate response to exercise. However, it is likely beneficial to track the total number of RB after the entire intervention, as it would indicate whether there is an overall reduction in RB, rather than just immediately after exercise. For example, an intervention for people with ID displayed a gradual decrease in repetitive movements throughout the duration of the intervention, whereas inappropriate vocalizations and off-task behaviour decreased, but did not further decrease throughout the intervention (Bachman & Sluyter, 1988). Furthermore, Bahrami et al. (2012) implemented a 14-week program during which individuals with ASD exercised four days a week. The severity of RB decreased following the intervention and remained decreased at a one month follow up (Bahrami et al., 2012). Thus, these results suggest that there is an overall reduction in RB when participants engage in a multiple intervention days and this reduction may persist past the cessation of the exercise intervention.

Although there were significant reductions in RB following exercise, most of the research involved children who were assessed in an academic facility. A limitation to this could be that reductions in RB were due to a break from their normal academic routine. However, Watters & Watters (1980) refute this theory, in their study examining RB in children with ASD before and after a typical academic condition, a T.V. watching condition, and an exercise condition. The results indicated that there was a decrease in RB only after the exercise precondition. If reductions in RB were attributed to a break

from academic learning, then the T.V. precondition should have shown reductions in RB as well (Watters & Watters, 1980).

Importantly, the literature also includes studies that did not find significant results. Magnusson et al. (2012) had six participants with ASD engage in a one-hour aerobic and resistance exercise session twice a week for 16 weeks. They gave the parents/guardians a questionnaire that assessed negative behaviours, including RB. The results indicated that there was a decrease in RB, however the results did not reach statistical significance (Magnusson et al., 2012). Additionally, Oriel et al. (2011) did not find a decrease in RB following a three-week exercise intervention. However, they attributed this to the lack of RB that their participants exhibited to begin with. Of their nine participants, four of them did not show any RB during observations, and the other five participants displayed only a minimal number of RB. However, four of the five participants who presented with RB exhibited no RB following exercise. This may show some effect of exercise on RB, however, the participants did not show enough RB to elicit significant results.

A suggested reason for the reduction of RB following exercise is that the participants are fatigued, which would result in a reduction in all behaviours. However, if the decrease in RB was due to fatigue, then follow-up measures should be at the same level as baseline (Bahrami et al., 2012). A reduction in all behaviours would include activities such as academic engagement; however this was not found to be the case. In fact, those who had a higher level of involvement in physical activity had an increase in academic engagement (Nicholson, Kehle, Bray & Heest, 2011; Oriel et al., 2011). Furthermore, individuals with ASD were not only more engaged in their academics, but

showed increases in academic performance and on measures of executive functioning in conjunction with a decrease in RB (Anderson-Hanely et al., 2011; Rosethal-Malek & Mitchell, 1997). Similarly, following exercise people with ASD displayed an increase in positive behaviours and 'on-task' behaviours (Kern et al., 1982; Magnusson et al., 2012; Powers et al., 1992). This is important in implementing exercise programs for adults with ASD because they need to be able to perform tasks in order to live independently. In addition to academic performance, Rosenthal-Malek & Mitchell (1997) assessed the performance of people with ASD in a community-based workshop. They found that after exercise there was an increase in completed workshop tasks such as placing eggs in a carton or counting beads. Similarly, Elliott et al. (1994) assessed two adult participants with ASD and ID who had maladaptive behaviours that disrupted their employment. Following aerobic exercise there was a decrease in RB and maladaptive behaviours, compared to non-exercise days, during the community-integrated vocational task which involved distributing advertising materials within the community (Elliott et al., 1994). These studies exemplify that exercise can help facilitate community integration for people with ASD.

Overall, exercise is a viable option as an intervention for reducing RB expression, for many reasons. If an individual working with a person with ASD wants to reduce RB, then exercise as an intervention is feasible because it does not require them to have behavioural training (Bachman & Sluyter, 1988; Watters & Watters, 1980). In addition, within educational settings, exercise reduced the number of RB before they occurred and did not disrupt classroom activities (Bachman & Sluyter, 1988; Rosenthal-Malek & Mitchell, 1997; Watters & Watters, 1980). Furthermore, exercise has been shown to

improve on-task behaviours and engagement in community-based activities (Elliott et al., 1994; Oriel et al., 2011; Rosethal-Malek & Mitchell, 1997). In conclusion, exercise is beneficial for people with ASD mentally and physically, and interventions that implement individualized vigorous aerobic exercise may be the most effective way to gain those benefits (Elliott et al., 1994; Kern et al., 1984; Pan & Frey 2006).

Literature Review Summary

In summary, there is an increase in prevalence of individuals with ASD and these individuals have lifelong impairments (Murphy et al., 2005; Ouellette-Kuntz et al., 2014; Wing & Potter, 2002). Moreover, people with both ASD and ID have an increased financial burden compared to people with ASD alone (Ouyang et al., 2014). RB are related to a decrease in adaptive functioning, which includes the ability to perform daily living skills (Smith et al., 2012). Exercise has been documented to reduce the number of RB for people with ASD and improve on-task behaviour (Kern et al., 1982). However, a number of the previous studies have only assessed children in an academic environment for various observation lengths (Celiberti et al., 1997; Kern et al., 1984; Oriel et al., 2011; Powers et al., 1992; Watters & Watters, 1980). Thus, more research is needed on adults with both ASD and an ID. Due to varying abilities and the types of RB that might be expressed by people with ASD and ID, assessing each person's progress separately is warranted.

From the review of literature above, the research questions for the current study were: (1) will people with ASD and ID exhibit fewer RB immediately following an aerobic exercise session, (2) will they show an improved ability to perform tasks immediately following an aerobic exercise session, and (3) will they display a reduction

in RB severity after engaging in a number of exercise sessions. I hypothesized that individuals with ASD and ID would: (1) exhibit an acute reduction in the number and duration of RB exhibited immediately following an aerobic exercise session, (2) improve in their ability to perform tasks immediately following an aerobic exercise session, and (3) have a reduction in RB severity after engaging in a number of exercise sessions.

CHAPTER 3: Methods

Participants

Through Community Living Essex County (CLEC), six adults with ASD and ID were recruited. Targeting six to eight participants during recruitment afforded the ability to conduct case studies on each individual and examine whether similar trends emerged among all of the participants. Conducting case studies permitted an in-depth understanding of each participant's RB and their progress throughout the program. During the exercise intervention each participant was accompanied by a guardian or support worker as an extra precaution to ensure their comfort and safety, and to facilitate communication with non-verbal participants. I was present at all of the exercise session, and normally had a volunteer assistant. In addition, four out of the six participants were familiar with me from my involvement in a previous research study.

Inclusion and Exclusion Criteria.

Clinical reports from CLEC confirmed each participant had been diagnosed with ASD and ID. The people supported by CLEC have an IQ that ranges from 70 to 20. Participant-specific IQ scores are not provided; however, participants were given the option to disclose this information on the diagnosis question of the participant profile (Appendix C). Representatives from CLEC contacted all potential participants during recruitment. CLEC encourages their supported population to explore different opportunities and exercise their rights. Thus, a standard protocol is to allow all participants the opportunity to consent for themselves. If a participant was unable to consent for themselves, then third-party consent was obtained from a parent or guardian.

See appendices D-K for the recruitment flyer, the recruitment package completion guide, and the consent and letter of information forms used.

For participants to be considered an adult they must be 18 years of age or older. To avoid recruiting participants that exhibited a low number of RB (Oriel et al., 2011) the research team decided that individuals had to score a minimum of '2'on at least one item on the stereotypic behaviour subscale in the RBS-R. This ensured that the participant engaged in a form of repetitive behaviour that could be tracked by the video observations.

As participants performed aerobic exercise, they were required to have their practicing physician complete a Physical Activity Readiness Medical Examination form (PARmed-X; provided in Appendix L; Canadian Society for Exercise Physiology, www.csep.ca/forms, 2002). This form is an extension of the Physical Activity Readiness Questionnaire (PAR-Q). The PARmed-X was used instead of the PAR-Q because people with ASD and ID may inaccurately assess their own capability to engage in physical activity. Thus, the individual's family doctor indicated if the participant was able to engage in physical activity. In addition, participants were asked to sign a rolling consent form before each exercise session (Appendix M).

Participants were excluded from the study if they are under 18 years of age, did not have a co-diagnosis of ASD and ID, and/or exhibited violent/aggressive behaviours. In addition, participants who were unable to complete the JHFT or scored less than a '2' on the stereotypic behaviour subscale in the RBS-R, were excluded from the study. Other forms of RB did not exclude a participant as long as they met the inclusion criterion for stereotypic behaviour. Participants who consistently engaged in a vigorous level of aerobic exercise prior to the start of the intervention were excluded from the

study. Previous literature suggested that vigorous levels of exercise intensity are needed to elicit reductions in RB; therefore, if an individual was regularly engaging in a vigorous form of aerobic exercise, the intervention would probably have little or no effect. The literature did not explore reductions that may occur after moderate-light intensity exercise, thus engaging in this form of exercise did not exclude participants from the study. Prior engagement in vigorous aerobic exercise was determined if the participants indicated it on the Participant Profile (Appendix C). Participants were excluded if they engaged in vigorous aerobic exercise two or more times a week for at least one month prior to the start of the intervention. If exercise two or more times a week for at least one month was indicated, then a support worker, parent, or guardian of the participant was contacted and was asked questions regarding the intensity of the participant's previous exercise. If participants were described as sweating, out-of-breath, and exercising at a fast rate for 20 or more minutes, they were excluded from the study.

Setting

The intervention was conducted in a space provided by CLEC. CLEC facilities were chosen due to the secluded area available for data collection, the familiarity that participants have with the location, and the proximity to participant residences compared to the University of Windsor. The reasons for choosing CLEC facilities may reduce disruptions that occur during data collection, decrease anxiety associated with unfamiliar locations, and makes traveling to the program easier for participants and support workers, parents, or guardians.

The chart below depicts the order of the testing procedures that occurred at CLEC and the time each it took to complete (Table 2). This protocol was implemented twice a

week for eight weeks. Each test instrument and details regarding the aerobic exercise used in this study are described in detail below. An availability check-list (Appendix N) was provided in the recruitment package to determine when participants were available. In addition, a minimum of 15 minutes was scheduled after each exercise session to ensure proper cleaning, and set up or tear-down of equipment.

Treatment and Independent Variable

Aerobic Exercise. A stationary bike (Monark Cardio Care 827E) was stored at CLEC and utilized for the study. A large Velo GelTech ® bike seat cover (Velo, Taiwan, Taichung) was provided for all exercise sessions to improve the comfort of the stationary bike. The benefits of utilizing a form of aerobic exercise have been displayed in previous studies, thus aerobic exercise was chosen as the intervention for the current study (Anderson-Hanley et al., 2011; Celiberti et al., 1997; Elliott et al., 1994; Kern et al., 1984; Kern et al., 1982; Levinson & Reid, 1993; Powers et al., 1992; Rosenthal-Malek & Mitchell, 1997; Watters & Watters, 1980; Yilmaz et al., 2004).

Additionally, performing aerobic exercise on a stationary bike is an individualized activity and there is research to suggest that people with ASD prefer and perform better

Table 2

Protocol for a Typical Day of Testing

2 min	Signing rolling consent
5 min	1st JHFT
8 min	1st Observation period
5 min	Warm up
20 min	Aerobic exercise
3 min	Cool down
8 min	2nd Observation period
5 min	2nd JHFT

with individually-focused activities rather than team-orientated activities (Pan & Frey, 2006; Ogg-Groenendaal, Hermans & Caessens, 2014). Moreover, the majority of studies outlined in Appendix B had participants engage in 15 to 20 minutes of exercise. Exercising more than 20 minutes may be too strenuous, whereas 10 minutes of exercise might not provide maximal benefits. Thus, 20 minutes of aerobic exercise was utilized for this study. Finkelstein, Barnes, Wartell, and Suma (2013) used the BODYMEDIA® armband (described below) and demonstrated that ten children with ASD were able to exercise vigorously up to 11 minutes in a 15-minute exercise session, which included a warm-up and a cool-down. Although participants may be able to exercise at a vigorous level, encouraging them to engage in moderate exercise at the beginning of the program would allow them to become accustomed to exercising on a bike and progress to vigorous exercise. Therefore, at the beginning of the intervention participants were asked to start exercising at a moderate level and throughout the intervention were encouraged to gradually increase toward a vigorous intensity level. Participants were not excluded from the study if they were unable to reach a vigorous level of intensity. The familiarization session indicated the base level of intensity at which the participant is comfortable exercising.

Magnusson et al. (2012) demonstrated that 16 sessions of exercise can elicit cardiovascular changes in individuals with ASD. Ellis et al. (1989) suggested that, for an individual with ID, the reduction in a targeted stereotyped behaviour (body rocking) may be related to an increased cardiovascular conditioning. Thus, a 16-session aerobic exercise intervention was chosen because it may result in a decrease in the duration of

RB exhibited throughout the program. For an exercise session to be considered 'completed' participants were required to exercise for a minimum of 10 minutes.

Exercise Intensity. To track the participant's exercise intensity level the BODYMEDIA® armband (BodyMedia Inc., Pittsburgh, US; Model Number 100701) was placed on the back of the upper left arm of each participant. This arm band was intended to connect to a monitor (SenseWear Display®; BodyMedia Inc., Pittsburgh, US; Model Number 100699) to indicate the level of exercise intensity. Unfortunately, the SenseWear Display® was consistently disconnecting from the participant's armband. Thus, detailed notes on speed, distance, and resistance level were recorded to in order to track participants' exercise performance.

The BODYMEDIA® software utilizes metabolic equivalents (METs) to indicate the participant's exercise intensity level. Engaging in exercise at three to six METs is considered a moderate level of intensity and six METs or higher is considered vigorous (Ainsworth et al., 2000). The BODYMEDIA® equipment utilized information such as the participant's age, sex, weight, and height with physiological measures to determine the participant's energy expenditure. The information collected from the BODYMEDIA® was downloaded to a secure laptop after each exercise session. This information indicated how many minutes the participant was exercising at a moderate or vigorous level. Furthermore, the bike provided a distance measurement, which was recorded once the participant had completed 20 minutes of aerobic exercise.

Verbal encouragement was used to try and keep the participant working at an optimal intensity throughout the entire 20 minutes. This encouragement included cheering, suggesting a speed or distance they needed to reach, and having either the

volunteer or me jog on the spot next to the bike. Similarly, some support workers would join in cheering and/or jogging next to the bike. Some participants benefited from setting a speed goal and once they achieved it, I would do a form of exercise as a reward (e.g., push-ups, jumping jacks, burpees, etc.). For some participants, I suspect that performing movements such as a push-up seemed odd and funny, thus they were encouraged to pedal faster to try and see the movement again. For other participants, it may have been a sense of comradery, rather than me simply watching their performance. Often multiple forms of encouragement were used and were constantly changing to keep the participant motivated.

Apparatus and Test Instruments

Jebsen Hand Function Test (JHFT). The JHFT is a measure of hand function and the subtests are related to various activities of daily living (Jebsen et al., 1969; Lynch & Bridle, 1989). The JHFT is made up of seven subtests, which include: writing, turning over cards, picking up small common objects, simulated feeding, stacking checkers, picking up large light objects, and picking up large heavy objects. This test can be applied to a clinical setting where improvements in performance can be tracked (Jebsen et al., 1969). In this study, the JHFT was used to represent tasks that an individual may perform in an independent living environment, so that I could determine whether a change in the expression of RB affected the individual's ability to perform these tasks. The JHFT was chosen due to its simplicity and its similarity to ADL which are important for adults with ASD and ID. The JHFT is reliable over time and has a high re-test reliability (Jebsen et al., 1969; Hackel et al., 1992; Carr et al., 2015). Jebsen et al., (1969) found that there was no practice effect for any of the subtests. Furthermore, the JHFT

was moderately correlated in predicting functional hand use in ADL (Lynch & Bridle, 1989).

Each of the JHFT subtests are typically performed on the non-dominant hand and then followed by the dominant hand. However, handedness is difficult to determine in people with ASD and ID, and there is a higher representation of left-handedness and mixed handedness in people with ASD compared to the general population (Carr et al., 2015; Lindell & Hudry, 2013). Participants or their support worker, parent, or guardian indicated the participant's handedness in the Participant Profile (Appendix C) and all individuals were reported as being right handed. Although handedness of the participant was collected, the purpose of the JHFT in this study was to indicate an individual's ability to perform a task, and not to determine their hand functioning per se. Thus, all participants were tested using their left hand followed by the right hand (Carr et al., 2015). Out of the seven subtests within the JHFT, six were used for the following study which included: turning over cards, picking up small common objects, simulated feeding, stacking checkers, picking up large light objects, and picking up large heavy objects. Pictures of each subtest used are located in Appendix O. The writing subtest was not used in this study due to the complicated nature of the task for people with ASD and ID (Carr, et al., 2015). A stopwatch was used to record the time it took a participant to compete each subtest. Participant completion of the JHFT before and after aerobic exercise were videotaped in order to reduce measurement error and will be used as a reference to aid in explaining unusual scores. The following descriptions of each subtest were described using the participant's right hand, however the wording was altered when the participant was required to complete the test with their left hand.

Card Turning. Five 7.6 cm by 12.7 cm index cards were arranged in front of the participant 12.7 cm from the edge of the table (marked with tape), and are 5 cm apart. Participants were asked to place their right hand in front of them on the table and place their left hand behind their back. When the researcher said "Go" the participant turned each card over starting at their far left. The cards do not need to be accurately placed after being flipped (Jebsen et al., 1969). Participants were timed from when the researcher indicated for them to start to when the last card is completely turned over.

Small Common Objects. An empty coffee can was placed 12.7 cm in front of the participant. Small objects were lined up to the right of the can, which included: two paper clips, two bottle caps (facing up), and two pennies that were placed 5 cm apart. The participant picked up each object individually and placed it into the coffee can, starting at the far right with the paper clips. The time was recorded from when researcher said "Go" to when the last item hit the bottom of the can.

Simulated Feeding. A wooden board was placed on the table 12.7 cm away from the participant. An empty can (8.7 cm diameter, 14.9 cm height) was placed centrally in front of the wooden board. Placed to the right of the can were five dried kidney beans 5 cm apart touching the upright portion of the wooden board. The dried kidney beans were 1.5 cm in length. A typical teaspoon was provided, and when the researcher said "Go," the participant used the spoon to pick up the kidney beans individually and place them in the coffee can. The time was stopped when the last kidney bean hit the bottom of the can.

Checkers. Four brown checkers were placed in front of the wooden board placed 12.7 cm away from the participant. Two checkers were placed on both the left and right

side of the board's center. Participants were required to stack the checkers one on top of the other on the wooden board. When the researcher said "Go" the participant could start with any checker and the time would stop when the last checker was stacked on top of the others.

Large Light Objects. In front of the wooden board placed 12.7 cm away from the participant were five empty cans (7.5 cm diameter, 11.3 cm height). Each can was placed facing down and 5 cm apart. When the researcher said "Go" the participant would place each can on the board in front of them. The time stopped when the last can was placed on the board.

Large Heavy Objects. In front of the wooden board placed 12.7 cm away from the participant were five 0.45 kg cans (7.5 cm diameter, 11.3 cm height) that are 5 cm apart. When the researcher said "Go" the participant would place each can on the board in front of them. The time stopped when the last can was placed on the board.

Video Observation. A Canon T3i Digital SLR camera (Canon; Mississauga, Ontario) positioned on top of a standard tripod was utilized to record the video observations. Video observation were used to assess the number and duration of RB an individual exhibits before and after aerobic exercise. Each observation period was eight minutes in length and was held in a secluded room with chairs, a table, and common objects such as a puzzle and magazines for the participant to interact with if they chose. The camera was stationed in a corner away from the participant, during the observation period. Only the social worker or guardian, a volunteer, and I were in the room during the entire exercise session including the video observations. This method of examining

RB was chosen because it allowed for the assessment of immediate changes in the number and duration of RB exhibited by the participant.

This research project utilized the entirety of the eight-minute observation period to determine the number and duration of RB exhibited. Interval time sampling methods (PIR and MTS) were not used because they may over- or underestimate the time an individual engaged in RB (Gardenier et al., 2004). Additionally, video recording allowed me to track when RB occurred and for how long, thus providing a more accurate assessment of the time an individual engaged in RB within the eight-minute observation period. Eight minutes was chosen to ensure that each data collection session could be completed within an hour. A one-hour session allowed me to administer the necessary protocols within the time and resources allotted by CLEC. Importantly, Celiberti et al. (1997) found that the largest decrease in RB occurred in the first ten minutes following the exercise intervention. Thus, an eight-minute observation period before and after exercise was chosen to assess the changes in the number and duration of RB.

During the video observations, a participant may have moved to face away from the camera or walked out of view before the camera could be repositioned. During that period of time RB may have occurred, but could not be tracked. This occurred relatively infrequently and did not affect the findings. Although, this was minimized with two techniques: (1) If a participant walked out of the camera frame while expressing a particular RB (e.g., *pacing)* and re-appeared within one second, then the duration tracked for that RB was continued; (2) If RB were partially obstructed, then the RB may have been deduced from other factors that occurred in the video such as: forearm movements

(e.g., for *rubbing surfaces/objects* RB), parts of an object moving (e.g., *shaking objects* RB), or sounds created from engaging in RB (e.g., the noise from *tapping objects*).

Repetitive Behaviour Scale-Revised (RBS-R). In this study, RBS-R was utilized as one of the inclusion criteria. Participants were included in the study if they exhibit at least a '2' on one of the items for stereotypic behaviours subscale. This ensured that the participant exhibited a behaviour that may be tracked by the video observation period.

In addition to administering the RBS-R to the support worker, parent or guardian prior to the start of the exercise sessions, a subsequent RBS-R was filled out by the same person following the completion of all exercise sessions (i.e., at the end of the 8-week program). The final RBS-R was filled out as soon as the support worker, parent or guardian was able to complete it. The difference between the RBS-R pre- and post-intervention scores was intended to assess any changes in the severity of RB displayed by participants.

In accordance with the results reported by Lam and Aman (2006), the RBS-R was scored utilizing the five-factor solution. Lam and Aman (2006) found that the questions used in the RBS-R loaded onto a five-factor solution compared to the original six factors. Moreover, the five-factor solution was rated between fair to good for inter-rater reliability and a high internal consistency (Lam & Aman, 2006). Appendix P includes the RBS-R and Appendix Q includes the Alternative Scoring Method for the RBS-R, which is used to score the questions using the five-factor solution (Lam, 2005).

The RBS-R has been used in previous studies to assess RB, including those that examine the effectiveness of an intervention on reducing RB (Baruth et al., 2010;

Chugani et al., 2016; Sokhadze et al., 2014). Although these studies used the six-factor solution, the five-factor solution may provide a more valid measure of RB severity (Lam & Aman, 2006). Additionally, the RBS-R was intended to add to the analysis of RB for each individual within the study. For example, the video analysis was predicted to capture more stereotypic behaviours rather than restricted interests. The RBS-R would allow for assessment of more complex behaviours that would otherwise be missed by video analysis.

Procedure

All data collection and interaction with the participants took place in a secluded room provided by the CLEC center. Participants were initially contacted through the managers at CLEC with a recruitment package. The RBS-R was included in the recruitment package (Appendices C-L, N, P) and was filled out by the participant's parent/guardian or support worker. Once the forms in the recruitment package were completed, the participants engaged in a familiarization session prior to data collection. The familiarization session allowed both the participants and the support workers or guardians to become comfortable with the equipment, testing procedures, and the research team (i.e., a volunteer and me). The familiarization session mimicked a typical day of data collection. Please refer to Table 2 (p. 47) for a depiction of the order of the testing procedures and the approximate time each took to complete.

At the beginning of each exercise day the participant or the support worker/guardian were given a rolling consent form (Appendix M), which asked if the participant had any recent visits to the hospital, any changes in medication, and if the participant would like to engage in exercise that day. Once consent/assent was received,

the participants were asked to perform a modified version of the JHFT. Following the JHFT, participants remained in a secluded room with their support worker, for eight minutes where they were allowed to move around the room freely, sit, or interact with objects located in the room such as puzzles and magazines. Following the eight minutes of observation, participants engaged in a five-minute warm up which consisted of dynamic stretches and exercises. A BODYMEDIA® armband was placed on the participant after they signed the rolling consent form and was removed when all activities for that day were completed. Following the warm up, participants engaged in 20 minutes of aerobic exercise on a stationary bike where they were verbally encouraged to pedal at a moderate to vigorous rate. Following exercise, participants cooled down by walking and stretching for three minutes. Participants went through another eight-minute observation period and the JHFT after the aerobic exercise. All JHFT and observation periods were videotaped to allow for subsequent review of the time it took to complete sub-tests and to assess RB, respectively. Each exercise day, including the observation periods and JHFT, took approximately one hour per participant.

Participants engaged in exercise sessions twice a week for eight weeks for a total of 16 exercise sessions, not including the familiarization session. After all exercise sessions were completed the support worker or guardian was asked to fill out another RBS-R (Appendix P). The two sets of RBS-R scores were compared to determine if there was a change in the severity of RB exhibited by the participant.

Data analysis

I anticipated that each person with ASD and ID might exhibit a distinct set of repetitive behaviours compared to another individual with the same diagnosis. Prior

experience with people with ASD and ID also indicated that variability between participants could be high. Thus, a practice-oriented case study approach was conducted on each participant to gain an in-depth understanding of their individual RB and the effect of aerobic exercise on these behaviours and task performance (Dul & Hak, 2008).

Video Observation. The video observations were coded for the number and duration of RB each participant engaged in. Since no previous studies had examined the number and duration of RB, I was unable to estimate which method would be more accurate. However, when I finished coding the videos, the duration of RB was a more representative measure than the number of RB. This is because the minimum duration that could be assigned to a behaviour that was short in duration was one second. Thus, for a repetitive behaviour such as *clapping*, the duration and frequency of RB were the same. RB that were longer in duration, such as *pacing*, were not accurately represented by simply counting the number of occurrences. Thus, all of the calculations and graphs described below were based on using the duration of RB in seconds. The difference between the duration of RB pre- and post-exercise was calculated. The duration of RB (pre-, post-exercise, and the total RB per session) and the difference in the duration of RB pre- to post-exercise for each session was plotted to determine if there is an observable change from the beginning to the end of the program. In addition, individual RB that occurred frequently were graphed to determine if there was a difference between the pre- and post-exercise or if there was a trend throughout the program.

JHFT. The total test score from the JHFT performed pre- and post-exercise were compared by calculating the percent difference. These percent differences were plotted

to determine if there is an observable difference from the beginning to the end of the program.

RBS-R. The RBS-R provided a general score for each subcategory and a score for the number items endorsed for that subcategory. Since the alternative scoring for the five-factor solution was used for the RBS-R, there are scores from five different RB categories instead of six. The alternative scoring method provided a total score of all five subscales as well as the total number of items endorsed. Since the purpose of this scale was to determine changes in RB severity, only the severity ratings, rather than the number of items endorsed, were compared. The change in RBS-R scores from the beginning to the end of the intervention were compared using the total and the subscale severity scores.

The items that changed within the stereotypic and self-injurious subscales were compared to the RB that emerged in the video observations. The trends in RB expression throughout the program from the video observations were used for this comparison. Each participant's result section highlights similarities and differences between the two measures. See Appendix R for a comprehensive table comparing RBS-R items from the stereotypic and self-injurious subscales all of the RB identified in the video observations. Note that two items within the stereotypic subscale (*preoccupation with part(s) of an object* and *fascination, preoccupation with movement/ things that move*) were not included in these tables because they could not be tracked by video observations.

Exercise Intensity. The BODYMEDIA® information was compared to the results from the video observation for each individual to determine whether there was an observable relationship between the duration of RB and intensity of aerobic exercise and

a reduction of RB. The information the BODYMEDIA® armbands provided on exercise intensity included the average MET value and the minutes the participant engaged in each level of exercise intensity (i.e., sedentary, light, moderate, vigorous, and very vigorous).

CHAPTER 4: Results

Six adults (five males and one female) with a co-diagnosis of ASD and ID were included in the study. The participants' ages ranged between 20 to 64 years. Each participant has a pseudonym for their respective sub-section. In order to protect the confidentiality of the female participant, androgynous pseudonyms were chosen and only male pronouns (i.e., he, his, him) were used to refer to each participant. In addition, each participant has an combined interpretation and summary section following their results. This section allowed for the ability to explain specific aspects of an individual's results while providing an overview. This format was beneficial because it avoided describing information in the discussion encompassing all participants where it may be out of context.

Participant #1: 'Dakota'

Dakota seemed to enjoy attending the program and readily interacted with both his volunteer and with me. He often wanted to complete the required tasks at an exceptionally fast pace and he benefited from verbal cheering during his biking sessions. Dakota exhibited a variety of RB. He frequently engaged in pacing, particularly during the initial sessions. Placing an object on/in his mouth was another common behaviour exhibited throughout the program.

Dakota: Video Observation.

Video Observation: Overview. Table 3 provides a list of RB and descriptions that emerged from coding Dakota's video observations. Figure 1 shows the difference in time spent engaging in RB between the pre- and post-exercise video observations. Dakota displayed an increase in RB immediately after biking in the majority of the sessions.

Specifically, the duration of RB was greater post-exercise than pre-exercise in 12 sessions (pre- to post-exercise difference ranging from four to 247 seconds), while the duration of RB was greater pre-exercise than post-exercise in four sessions (pre- to post-exercise difference ranging from 44 to 475 seconds). In addition, Dakota showed a decrease in total time engaged in RB exhibited throughout the program. Figure 2 depicts the duration of all RB pre-exercise, post-exercise, and the sum for each session.

Table 3

Dakota: List of RB

Type of RB exhibited	Description of RB
Mouth	- Biting finger and/or self - Moving hand on mouth
Mouth and Object	- Biting an object - Pressing object in or against mouth
Object Interactions	- Shaking or tapping objects - Using an object to tap a surface - Spinning deck of cards in hands
Hand Movements	- Abnormal finger movements - Slapping a part of their own body - Clapping hands - Hand movements in front of their face - Rubbing face, head, or neck
Swinging Arms	- Moving arms from front to back of body, typically when pacing
Body-Rocking	- Swaying torso forward and back
Pacing	- Walking throughout the room without an observable purpose
Close Face	- Typically performed when pacing. Involves stopping abruptly and in close proximity to the face of the primary researcher, volunteer, or support worker
Rubbing Surfaces	- Using hands to rub walls, tables, or objects
Contact with Another	- Feeling or rubbing the hair of the primary researcher, volunteer, or support worker - Placing or moving to touch another's hair to their mouth

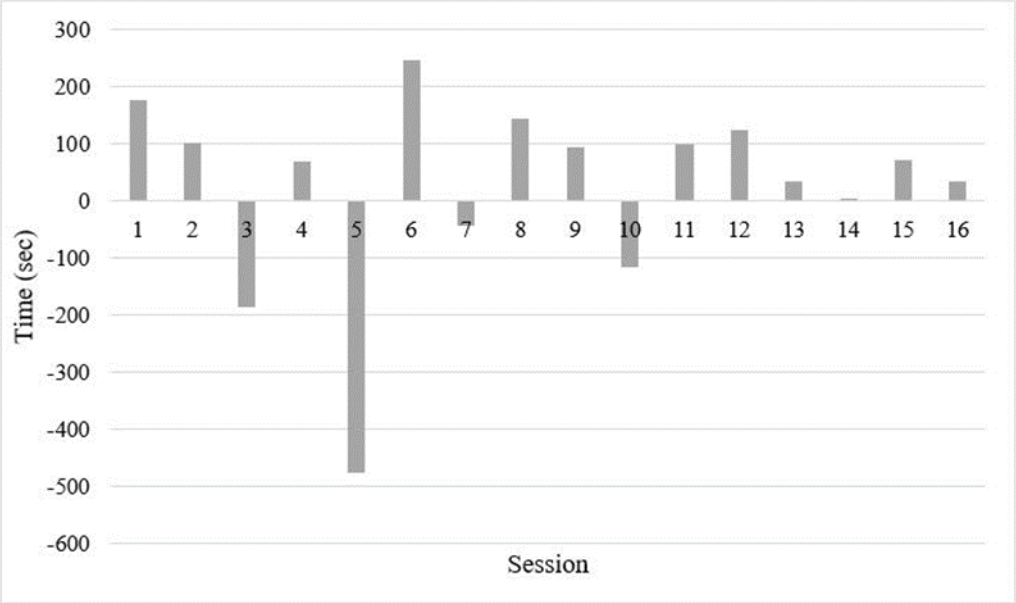


Figure 1. Dakota: The difference in time spent (in seconds) for all RB exhibited pre/post exercise.

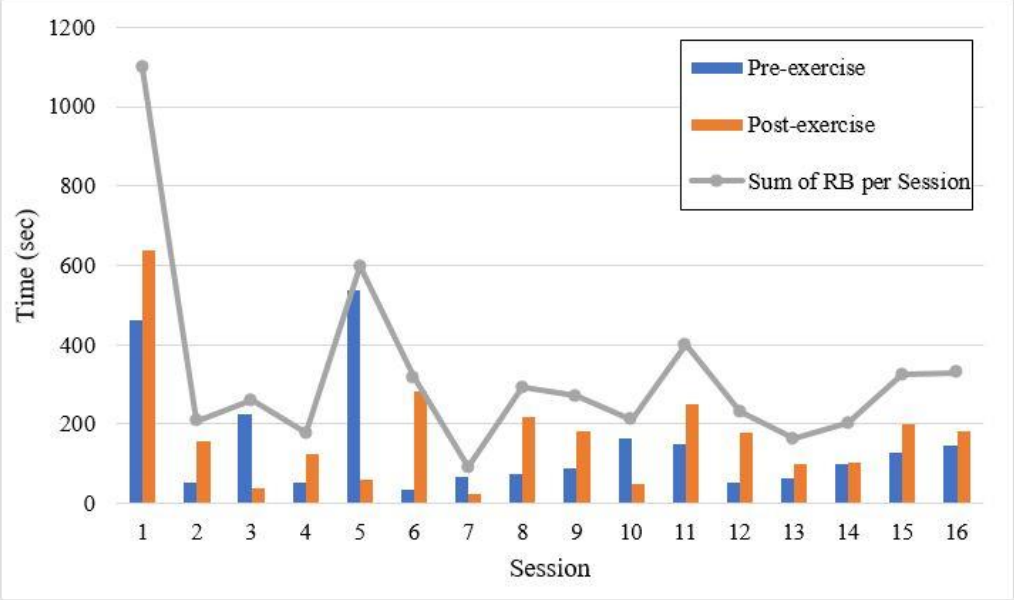


Figure 2. Dakota: The time spent (in seconds) for all RB exhibited pre/post exercise and per session.

Video Observation: Specific RB. When RB were examined individually, both *pacing* and *pacing-related* RB (*close face*, *contact with another*, and *swinging arms*) stopped after the fifth session (see Figure 3). Three RB (*tapping objects*, *using an object to tap another object/surface*, and *clapping*) decreased throughout the program. Conversely, six RB increased in duration throughout the program (*biting objects*, *placing object in or on mouth*, *shaking objects*, *spinning cards*, *body-rocking*, and *rubbing objects/surfaces*). See Figure 3 for the duration of RB that increased. Furthermore, two RB (*biting hand/finger* and *hand/mouth movements*) did not occur as frequently as some other RB, but tended to be expressed at the beginning and the end of the program (see Appendix S).

Dakota: JHFT Performance. The percent difference in JHFT scores from pre- to post-exercise were calculated for each subtest and each hand. All the percent

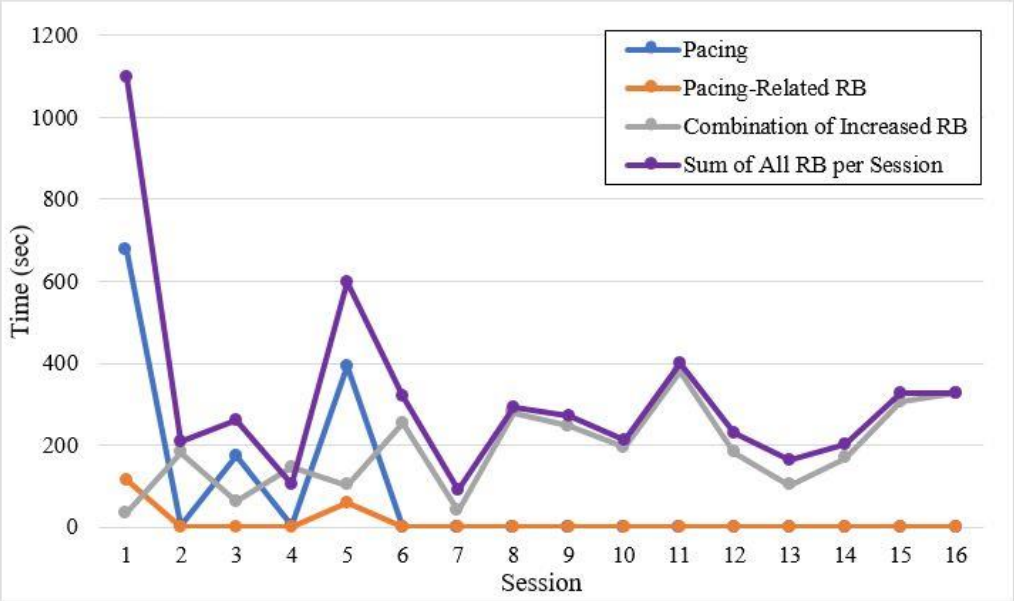


Figure 3. Dakota: The time spent (in seconds) engaging in *pacing*, *pacing-related* RB (i.e., *contact with another*, *swinging arms*, and *close face* RB), a combination of the RB that increased (*biting objects*, *placing object in or on mouth*, *shaking objects*, *spinning cards*, *body-rocking*, and *rubbing objects/surfaces*), and the total duration of all RB.

differences (six subtests for both hands; 12 in total) were averaged to provide an overall change in score for each session. Figure 4 depicts the average percent difference results for each session. The percent difference range from -24.3% to 35.8%. Overall, no consistent trend emerged.

Dakota: RBS-R. The total score was 48 pre-intervention, and was 39 post-intervention. Table 4 provides the pre- and post-intervention results for the five subscales. The severity rating for *self-injurious*, *compulsive*, and *ritualistic/sameness* behavior decreased, whereas the rating for *stereotypic behavior* and *restricted interests* increased. Within the five subscales, 14 items decreased and six items increased in RB severity.

Within the *stereotypic behaviour* subscale (rated by his support worker), the *head* item increased in severity rating (on a scale from zero to three) from one to two. However, *head turning/nodding* RB did not occur in any of my video observations.

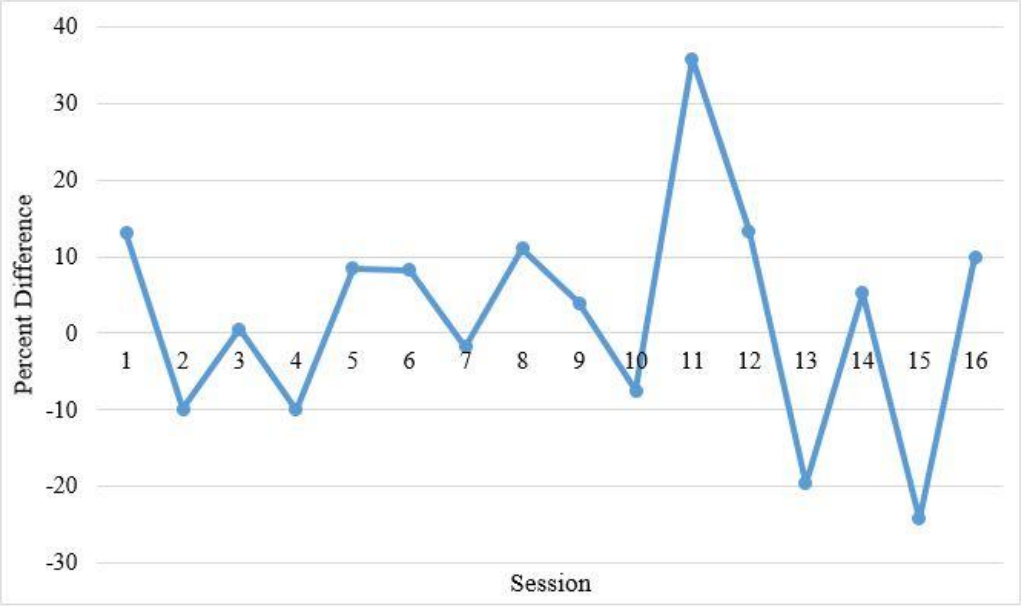


Figure 4. Dakota: The percent difference of the JHFT scores between pre- and post-exercising.

Table 4

Dakota: RBS-R results

RBS-R Subscales	Pre-Intervention	Post-Intervention
Stereotypic Behavior*	8	10
Self-Injurious Behavior*	15	10
Compulsive Behavior	11	7
Ritualistic/Sameness Behavior	12	9
Restricted Interests	2	3

*subscale contained items that were tracked by video observations

In addition, the *locomotion* item was rated both pre- and post-intervention as zero, but *pacing* occurred frequently at the beginning of the program. Within the *self-injurious* subscale, the *bites self* item decreased from a three to a two. The video observations display *biting hand/finger* peaking at both the beginning and the end of the program. The item for *hits self with body part* shows a consistent rating of three. The RB related to this in the video observations (i.e., *slapping himself*) displayed a decrease, however it did not occur often enough to suggest a consistent trend.

Dakota: Biking performance. Dakota's average MET level per exercise session ranged between 2.0 and 6.8 with an average of 5.3. Dakota exercised at a moderate intensity level (3-6 METs) 37% of the time, and at a vigorous intensity level (6-9 METs) 46% of the time. Dakota engaged in *body-rocking* while biking in 13 out of the 16 sessions, which might have altered the level of moderate-vigorous intensity tracked. I noted that on two of those days, Dakota's *body-rocking* was intense enough to cause a shift the bike's position. Additionally, I noted that Dakota was overly excited during four exercise sessions, which included prolonged laughing fits that caused reddening of the face and reduced ability to take in deep breaths. Consequently, Dakota's support worker, the volunteer, and I would have to tell Dakota to stop or slow down to practice breathing

before resuming exercise. Three of these four sessions showed a reduced level of exercise performance.

Interpretation and Summary of Dakota's Results. Due to the lack of a consistent decrease in RB after exercising, the first hypothesis of an immediate decrease in RB was not supported in Dakota's case. The results from Dakota's video observations suggest that there may be interaction between different RB. After the reduction in pacing, Dakota preferred to be seated at the table with activities, which may have made it easier to engage in other RB (i.e., body-rocking and rubbing object/surfaces). Although pacing involved a large amount of time compared to body-rocking and rubbing object/surfaces, the increase in these RB was not large enough to account for the reduction in pacing.

Since there was no observable trend in JHFT scores, the second hypothesis of an improvement in task performance was not supported. A reduction in the total score for the RBS-R supports the third hypothesis, where there was a decrease in RB severity by the end of the program. It is important to note that there were large differences between pre- and post-intervention scores. One of these differences was the change in four items from "does not occur" to "occurs and is a mild problem". Additionally, Dakota consistently exercised at a moderate-vigorous rate, with the exception of one day.

Participant #2: 'Morgan'

Morgan was a calm individual who started the program wanting to exercise fast on the bike. To keep him pedalling fast, I would set a speed he needed to reach. If he reached this speed, I would do a form of exercise myself as a reward (typically push-ups).

He engaged in relatively few types of RB and his most distinct RB was his *in front of face hand movements*.

Morgan: Video Observation.

Video Observation Analysis: Overview. Table 5 provides a list of RB and descriptions that emerged from coding Morgan's video observations. It is important to note that Morgan was allowed bring in his iPod and listen to music (without headphones) during the video observations. This started after the trial session due to Morgan's confusion on whether he was allowed to interact with the objects provided. I asked his support worker if there were any objects at home he typically interacted with and she suggested the iPod. From session one to 16 the iPod was presented along with all the other objects and Morgan was told he could choose to interact with any object. Morgan chose to interact only with his iPod throughout the program, with the exception of rubbing surfaces such as the table or chair.

Morgan displayed a decrease in the duration of RB from pre- to post-biking in the majority of the sessions. Specifically, the duration of RB was greater pre-exercise than post-exercise in 11 sessions (pre- to post-exercise difference ranging from nine to 183 seconds), while duration of RB was greater post-exercise than pre-exercise in five sessions (pre- to post-exercise difference ranging from 21 to 47 seconds). Figure 5 displays the difference in time spent engaging in RB between the pre- and post-exercise video observations. Despite the majority of the sessions decreasing from pre- to post-exercise, the duration of RB exhibited per session increased throughout the intervention (see Figure 6)

Table 5

Morgan: List of RB

Type of RB exhibited	**Description of RB**
Mouth	- Placing hand on mouth - Visibly pushing tongue into side of cheek or under lips
Rubbing Surfaces	- Using hands to rub table or objects
Object Interactions	- Tapping objects
Hand Movements	- Abnormal finger movements Repetitive "cracking knuckles" motion
In front of Face Hand Movements	- Moving fingers and/or twisting wrist in front of face/eyes - Includes in front of face hand movements where light tapping on face was integrated into movements
Body Movements	- Body-rocking - Shaking or tapping legs on ground
Head Turning/Nodding	- Moving head in a vertical or horizontal direction
Contact with self	- Touching head or face - Scratching head or face (not injurious) - Rubbing or tapping a body part (i.e., rubbing stomach or tapping arm)

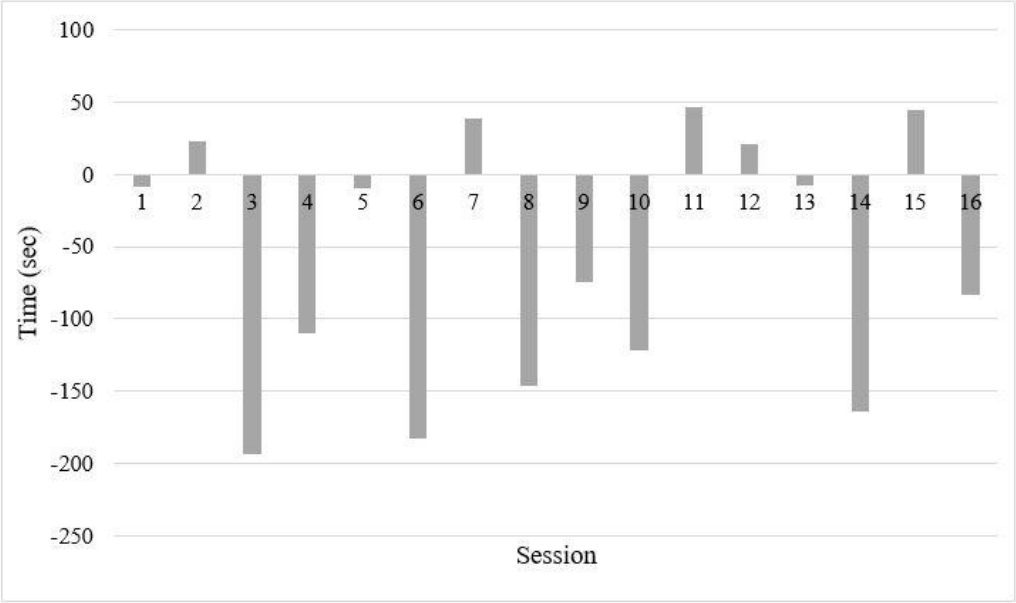


Figure 5. Morgan: The difference time spent (in seconds) for all RB exhibited pre/post exercise.

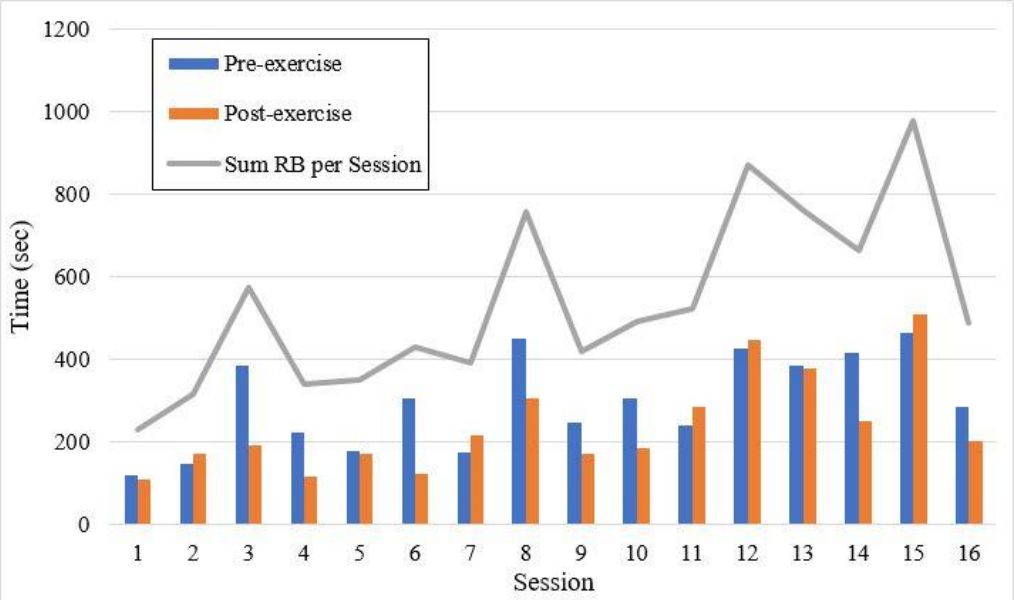


Figure 6. Morgan: The time spent (in seconds) for all RB exhibited pre/post exercise and per session.

Video Observation: Specific RB. When examined individually, eight of Morgan's RB increased in duration throughout the program (i.e., *in front of face hand movements, rubbing objects/surfaces, pushing tongue into cheek* behaviours, *head turning/nodding, rubbing or tapping a body part, cracking knuckles motion, hand to mouth,* and *touching head/face*). Figure 7 exemplifies three of the RB that increased. Three RB decreased throughout the program: *tapping objects, scratching head/face,* and *finger movements* (see Figure 8). *Body-rocking* did not display a trend throughout the program, but was evident more often pre- versus post-exercise (see Figure 9). The RB *shaking legs/tapping feet* peaked at the beginning and end of the exercise program and occurred more frequently pre- versus post-exercise (Appendix S).

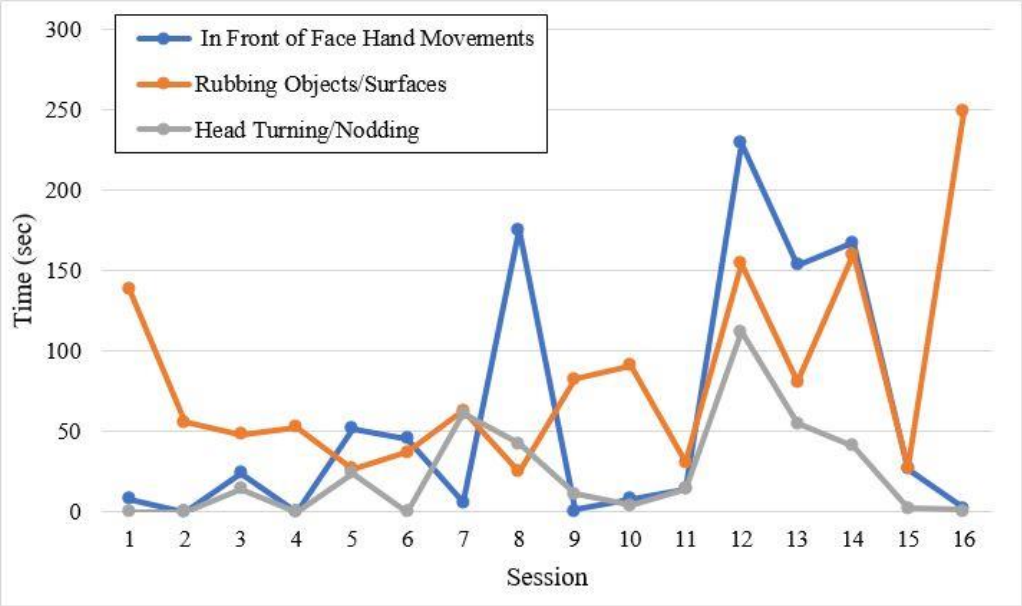


Figure 7. Morgan: The time spent (in seconds) per session for three example RB that increased throughout the program (*in front of face hand movements*, *rubbing objects/surfaces*, and *head turning/nodding*).

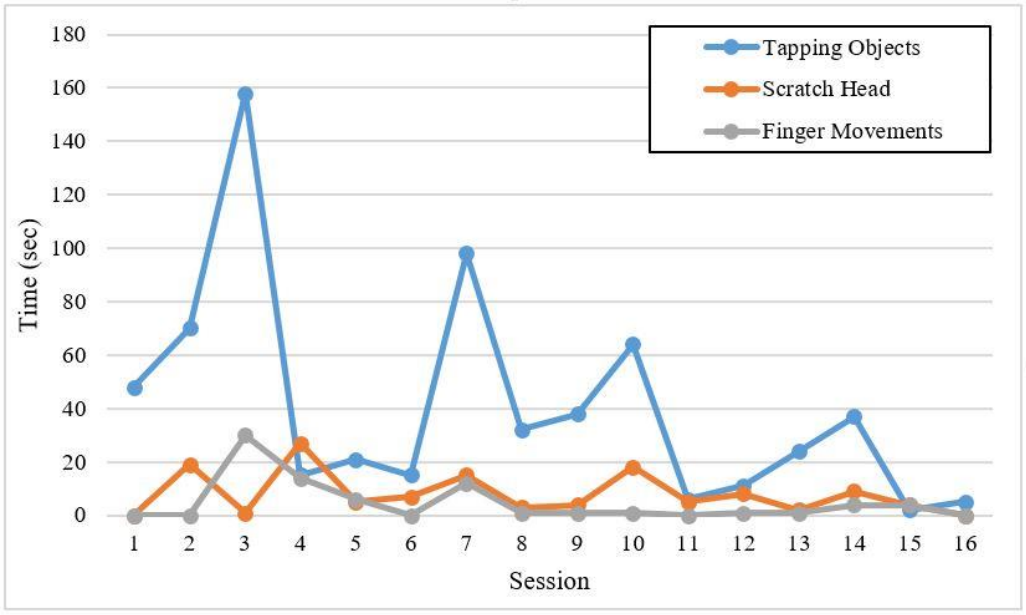


Figure 8. Morgan: The time spent (in seconds) per session for *tapping objects*, *scratching head/face*, and *finger movements* RB.

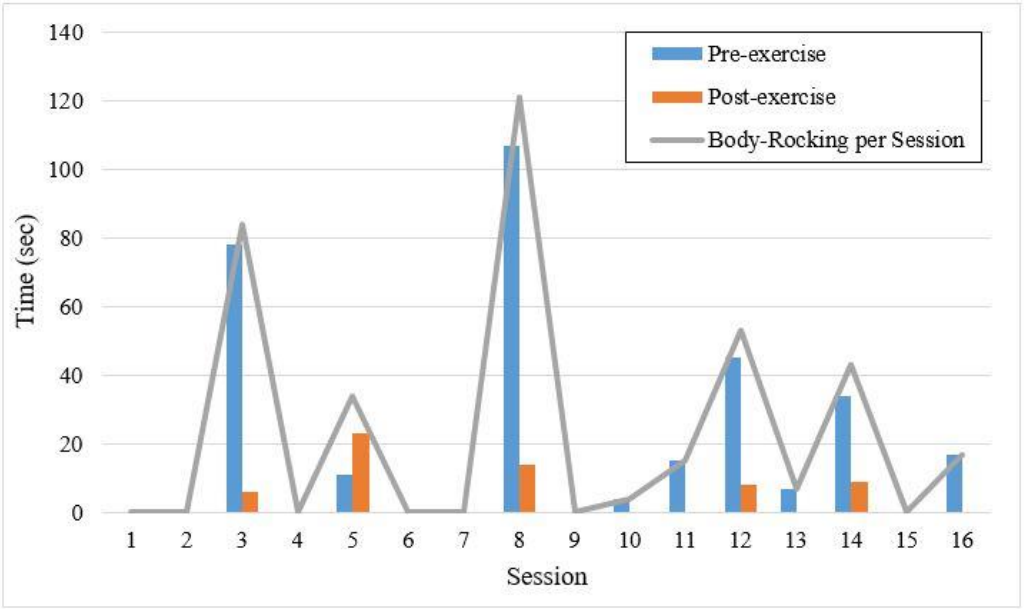


Figure 9. Morgan: The time spent (in seconds) *body-rocking* pre/post-exercising and per session.

Morgan: JHFT Performance. Figure 10 depicts the percent difference results comparing pre- to post-exercise JHFT scores. These results ranged from -17.1% to 28.4%. Overall, no consistent trend emerged.

Morgan: RBS-R. The total score was 10 pre-intervention, and was 7 post-intervention. Table 6 provides Morgan's pre- and post-intervention results for the five subscales. The severity rating for the *stereotypic*, *self-injurious*, and *restricted interests* subscales stayed the same, whereas the ratings for *compulsive behavior* and *ritualistic/sameness behavior* decreased. Within the five subscales rated by his mother, one item increased and four items decreased in RB severity. Regarding the *stereotypic behaviour* subscale, the *whole body* item (body-rocking, body swaying) increased from a rating of one to a two, whereas my video observations depicted no consistent trend for *body-rocking* throughout the program. The *head* item (rolls, turns, or nods head) decreased from a one to a zero, however the video results suggest an increase in *head turning/nodding* RB. A self-injurious item, *pulls* (pulls hair or skin), stayed the same

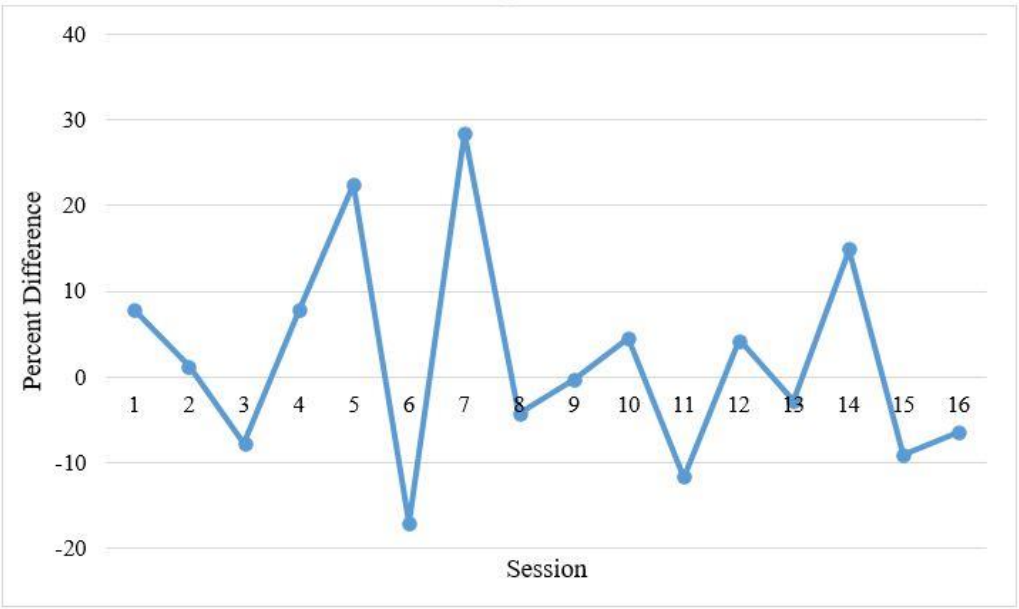


Figure 10. Morgan: The percent difference of the JHFT scores between pre- and post-exercising.

Table 6

Morgan: RBS-R results

RBS-R Subscales	Pre-Intervention	Post-Intervention
Stereotypic Behavior*	5	5
Self-Injurious Behavior*	2	2
Compulsive Behavior	1	0
Ritualistic/Sameness Behavior	2	0
Restricted Interests	0	0

*subscale contained items that were tracked by video observations

(rating of one) and was supported by inconsistent appearances of pulling hair in the video results.

Morgan: Biking Performance. The average level of METs per exercise session for Morgan ranged between 4.2 and 6.9 with an average of 5.9. Morgan exercised at a moderate level of intensity (3-6 METs) 31% of the time and 50% of the time at a vigorous level (6-9 METs) of intensity. Additionally, Morgan exercised at a very vigorous intensity level (≥9METs) on five occasions for one and two minutes.

Interpretation and Summary of Morgan's Results. Most of the exercise sessions showed an immediate decrease in RB from pre- to post-exercise, suggesting support for the first hypothesis. However, there was an increase in the total duration of RB throughout the program. Within the video observations there was a reduction in shaking legs/tapping feet RB during the middle of the program. This reduction might be due to a temporary change in the room where the exercise sessions were held. Morgan was seated at a desk with little leg room provided which might have reduced his *shaking legs/tapping feet* RB. For a different RB, the notes I took on each session suggested that the *in front of face hand movements* may be performed when Morgan is happy or excited. Although, is unclear why other behaviours may have increased, such as *rubbing objects/surfaces* or *head turning/nodding* behaviours. However, if some RB are an

expression of a positive mood or feeling, this suggests that some RB may not need to be targeted for intervention. The JHFT results did not show a consistent decrease from pre- to post-exercise, as expected, and do not provide support for the second hypothesis. Finally, the RBS-R results suggest a decrease in RB severity from pre- to post-intervention, which provides support for the third hypothesis. With regards to biking performance, Morgan consistently exercised at a high level, reaching a vigorous intensity level in all but one of the exercise sessions.

Participant #3: 'Reese'

Reese was an energetic individual who enjoyed asking a number of questions. While biking, he benefited from cheering and having his support worker and me jog next to the bike. Reese engaged in a wide variety of RB that were short in duration, but occurred frequently.

Reese: Video Observation.

Video Observation: Overview. Table 7 provides a list of RB and descriptions that emerged from video observation coding for Reese. Figure 11 shows the difference in the time spent engaging in all RB between pre- and post-exercise video observations. Reese displayed a decrease in the duration of RB from pre- to post-exercise in the majority of his exercise sessions. Specifically, the duration of RB was greater pre-exercise than post-exercise in 11 sessions (pre- to post-exercise difference ranging from 20 to 62 seconds), while duration of RB was greater post-exercise than pre-exercise in five sessions (pre- to post-exercise difference ranging from six to 108 seconds). Despite the decrease in the duration of RB from pre- to post-exercise, the sum of RB exhibited per session increased throughout the program (see Figure 12).

Table 7

Reese: List of RB

Type of RB exhibited	**Description of RB**
Mouth	- Tapping or placing hand on mouth - Licking finger - Biting back of hand
Mouth and Object	- Licking an object - Pressing object against mouth - Blowing on an object
Object Interactions	- Using object to tap head or face - Shaking or flapping objects - Tapping objects - Using an object to tap a surface, another object, or one's self - Ripping book pages
Hand Movements	- Hitting head/nose or another body part - Abnormal finger movements - Sticking arm out straight in a pointing motion - Clapping/waving hands - Hand movements in front of face - Wiping or touching face or head - Rubbing/wiping a part of one's body - Slightly pulls at hair
Head Movements	- Moving head in a nodding motion or turning to the side
Body movements	- Body-rocking - Jumping - Hoping while seated - Shrugging shoulders
Leg movements	- Tapping feet - Shaking legs
Rubbing Surfaces	- Using hands to rub tables or objects
Visual	- Using one finger to poke the lower/outer corner under his eye

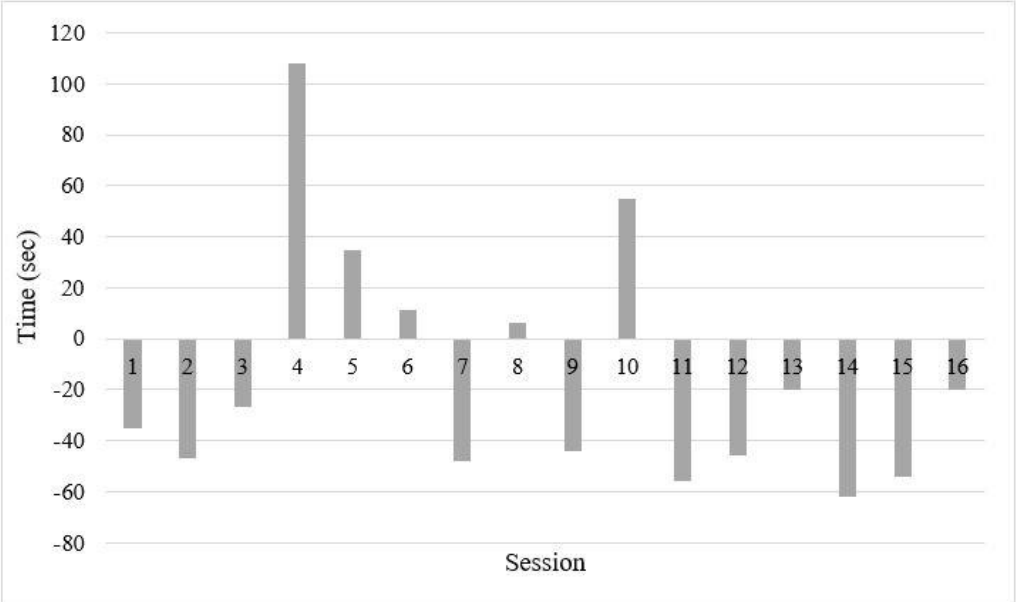


Figure 11. Reese: The difference in time spent (in seconds) for all RB exhibited pre/post exercise.

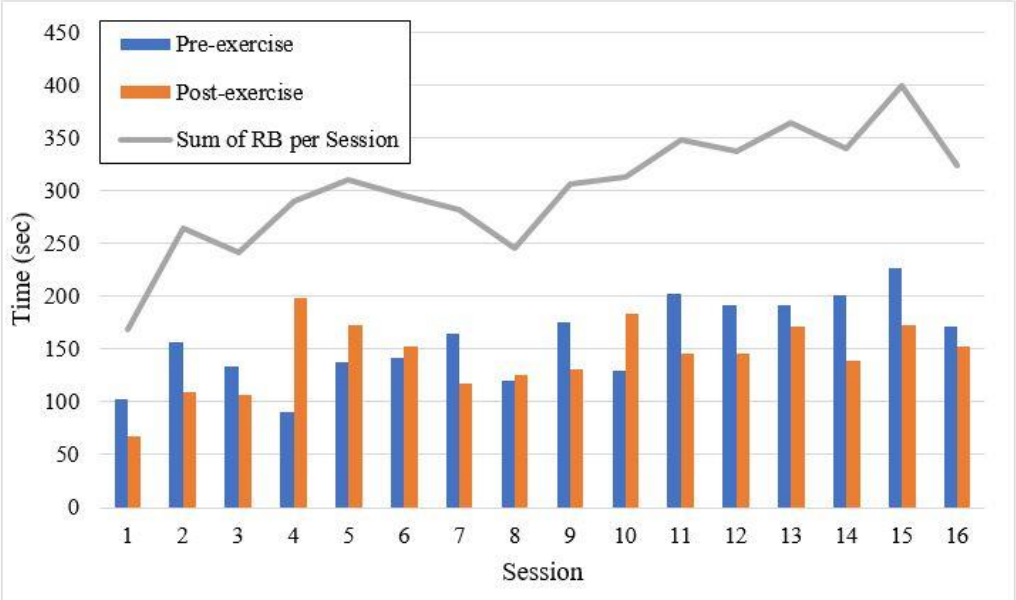


Figure 12. Reese: The time spent (in seconds) for all RB exhibited pre/post exercise and per session.

Video Observation: Specific RB. Reese exhibited a large variety of RB. The RB that could be represented graphically are separated into four main categories: visible increase in RB; RB occurred less frequently but suggests an increase; visible decrease in RB; and RB occurred less frequently but suggests a decrease. The RB that could not be represented graphically did not appear frequently enough to draw conclusions and were omitted from this section. Six types of RB appeared to increase in duration throughout the program: *clapping/waving hand*, *using object to tap or hit head*, *shaking/flapping objects*, *rubbing surfaces/objects*, *head nodding/turning*, and *tapping an object/using an object to tap*. Figure 13 displays three of these RB (i.e., *clapping/waving hand*, *using object to tap or hit head*, and *shaking/flapping objects*). In addition, five RB appeared to increase when represented graphically, but did not occur frequently enough to provide a large distinction from the beginning to the end of the program. These RB include: *hitting or tapping head*, *licking finger*, *ripping book pages*, *biting hand*, and *rubbing/wiping a part of body*. Figure 14 depicts three of these behaviours (*licking finger*, *ripping book pages*, and *biting hand*).

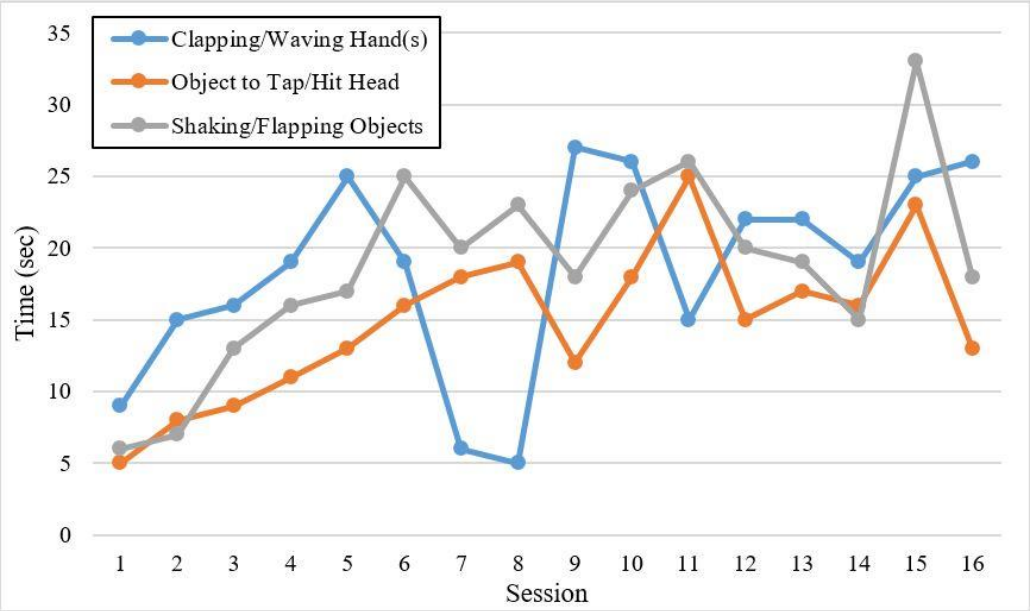


Figure 13. Reese: The time spent (in seconds) per session for three example RB that increased throughout the program (*clapping/waving hand*, *using object to tap or hit head*, and *shaking/flapping objects*).

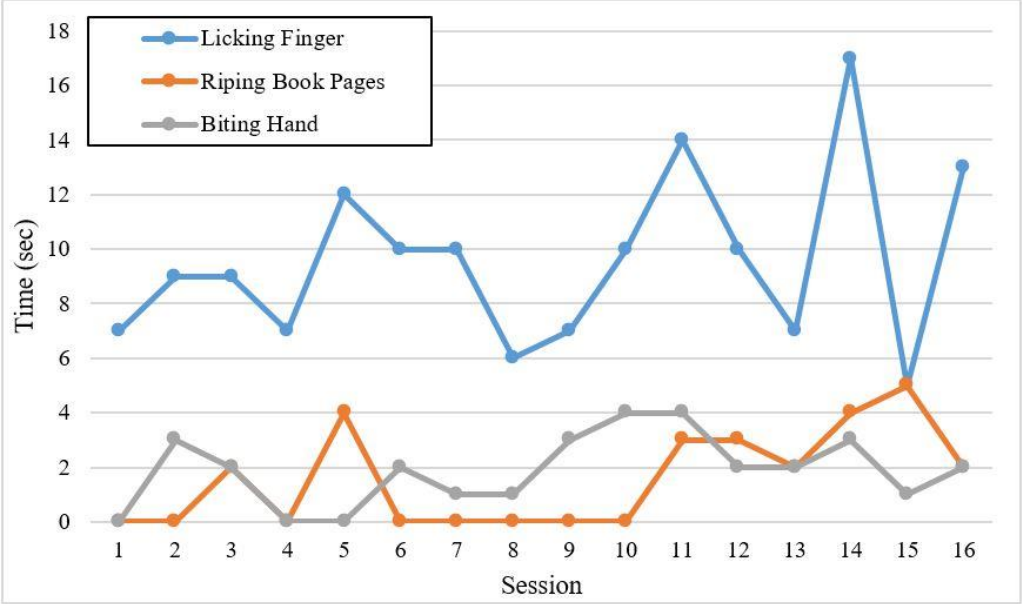


Figure 14. Reese: The time spent (in seconds) per session for three example RB occurred less frequently but suggests an increase (*licking finger*, *ripping book pages*, and *biting hand*).

The RB that displayed a decrease in duration over the course of the program were *in front of face* and *hand-to-mouth movements*. These two types of RB were grouped together due to their similarity of hand position and movement in front of the face. Figure 15 shows the sum of these behaviours throughout the program. In addition, *poking under eye* and *body-rocking* RB appeared to decrease throughout the exercise sessions, but did not occur often enough to display a distinct change from the beginning to the end of the intervention (see Figure 16). In most the sessions, *rubbing surfaces/objects* and *licking finger* occurred in higher durations before versus after biking. Conversely, *hitting self/body part*, *finger movements*, *shaking objects*, and *rubbing/wiping a part of one's body* had higher duration post- versus pre-exercising.

A behaviour that was not included in Reese's list of RB is pronounced eye squinting. The presentation of this behaviour was short in duration and included facial movements such as: furrowing his eyebrows, squinting, wrinkling up his nose, and scrunching his mouth. The rationale for tracking this behaviour was because it typically occurred before a rapid number of RB were performed. The total number of seconds this behaviour was expressed per session increased throughout the program (see Figure 17).

Reese: JHFT Performance. Figure 18 depicts the percent difference results comparing pre- to post-exercise JHFT scores. The percent difference range from -3.3% to 43.2%. Reese took longer to complete the JHFT after exercise in most the sessions (15 sessions; ranging from 11.8% to 43.2%), whereas only one session showed a decrease in time (-3.3%).

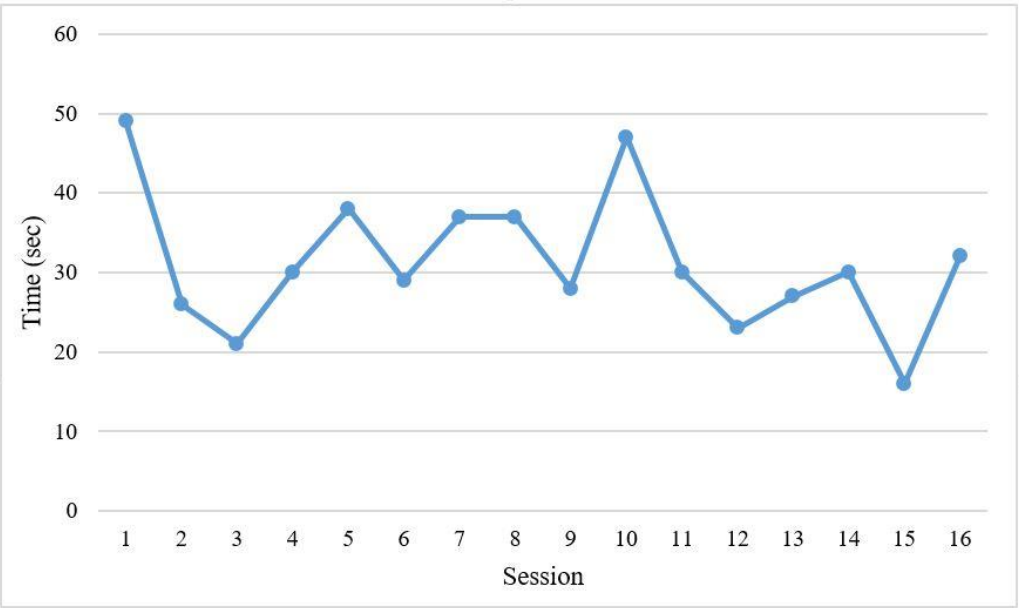


Figure 15. Reese: The time spent (in seconds) per session for the RB that decreased throughout the program (*in front of face* and *hand-to-mouth movements*).

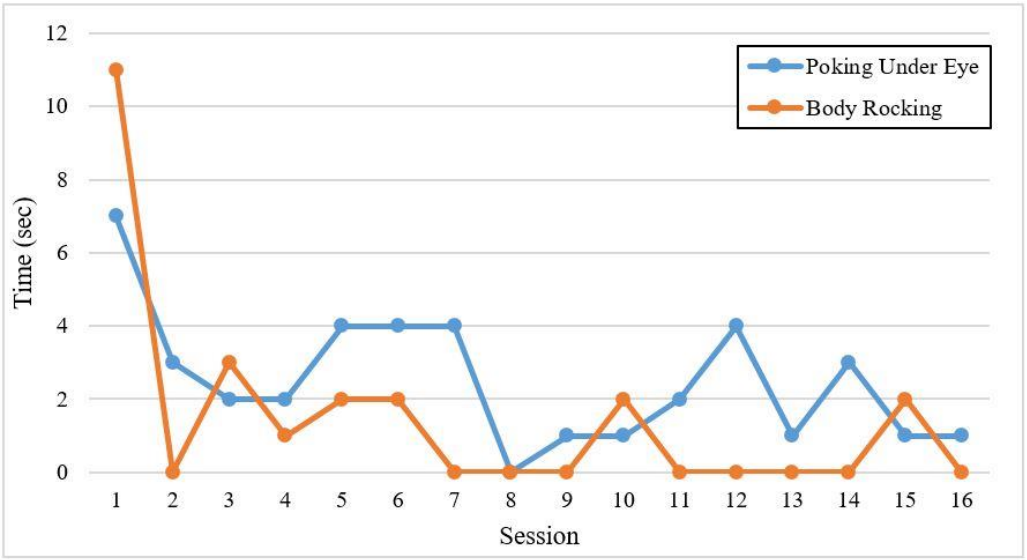


Figure 16. Reese: The time spent (in seconds) per session for the RB that occurred less frequently but suggests a decrease (*poking under eye* and *body-rocking*).

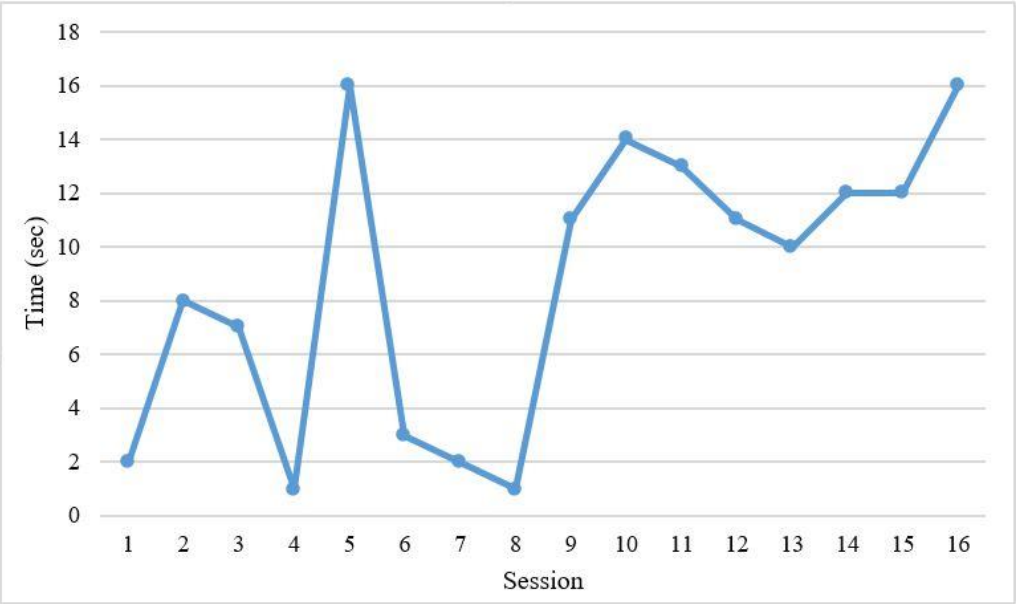


Figure 17. Reese: The time spent (in seconds) per session engaging in *pronounced eye squinting*.

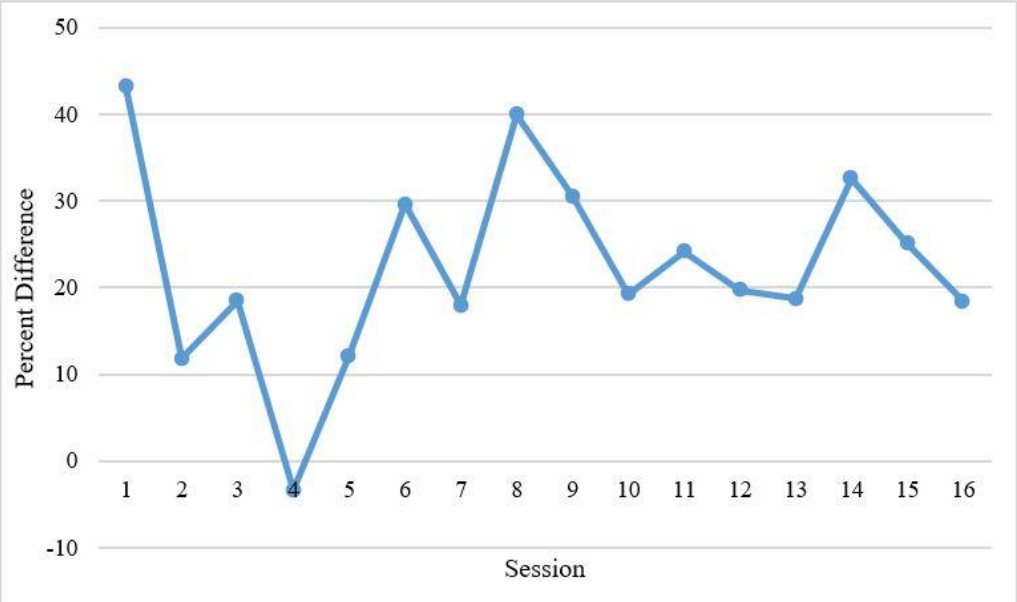


Figure 18. Reese: The percent difference of the JHFT scores from pre- to post-exercise.

Reese: RBS-R. The total score was 10 pre-intervention, and was 51 post-intervention. Table 8 provides Reese's pre- and post-intervention results for the five subscales. Large increases occurred in three subscales: *stereotypic behavior, self-injurious behavior, ritualistic/sameness behavior*. The *compulsive behavior* subscale increased by a severity rating of two (pre-intervention score of three and post-intervention score of five), and *restricted interests* increased by one (pre-intervention score of zero and post-intervention score of one). It is important to note that one item within the *stereotypic behaviour* subscale (*object usage*) was not filled out in the pre-intervention RBS-R, yet was rated as a three in the post-intervention RBS-R. Excluding the *object usage* item, 23 items increased and two items decreased.

Results for the *stereotypic behaviour* subscale and the video observations showed an increase in *head* movements (*head nodding/turning*), *touch/tap objects*, and *sensory* movements (*rubbing surfaces/objects*). Note that *rubbing surfaces/objects* could be considered an example RB for either *touch/tap objects* or *sensory* movement items. Both items use 'rubbing or rub surfaces as an example for each item'. Nonetheless, another *sensory* RB (*in front of face hand movements*) decreased in the video observations throughout the program. In addition, the *whole body* item from the *stereotypic subscale*

Table 8

Reese: RBS-R results

RBS-R Subscales	**Pre-Intervention**	**Post-Intervention**
Stereotypic Behavior*	9	22
Self-Injurious Behavior*	1	12
Compulsive Behavior	3	5
Ritualistic/Sameness Behavior	5	11
Restricted Interests	0	1

*subscale contained items that were tracked by video observations

increased, whereas the video observations suggested that *body-rocking* decreased. My video observation results regarding *jumping/hopping/shrugging* RB were inconclusive, thus cannot be compared to the *locomotion* item.

Regarding the self-injurious subscale, the item for *hits self with object* increased in both subscale rating (zero to three) and in the video observations (*object to tap/hit head*). It is important to note that the *hits self against object or surface* RB occurred in video observations early in the program, but was initially rated as a zero (behaviour does not occur). The *bites self* item increased (zero to one) and paralleled my observations on the *biting hand* RB during the video observations. The *hits self with body part* item increased (one to three), whereas the video results suggested a slight increase in *hitting/tapping head* but did not occur frequently throughout the program. In addition, these behaviours were initially rated as a zero by Reese's support worker, but did appear in the video observations early in the program. The *inserts finger or object* item (i.e., eye-poking or ear-poking) increased (zero to one), whereas the video observation suggests that *poking under the eye* RB was infrequent but suggested a decrease. Overall, within all the subscales there was a drastic change in items scored from pre- to post-intervention (excluding *object usage* item 25 changed).

Reese: Biking Performance. The level of METs per exercise session for Reese ranged between 1.1 and 6.1 with an average of 3.9. Reese exercised at a moderate level intensity (3-6 METs) 27% of the time and 33% of the time at a vigorous intensity level (6-9 METs). Overall, Reese's biking performance was variable with the highest average METs occurring in sessions one and 16, and the lowest METs occurring in sessions three and seven.

Interpretation and Summary of Reese's Results. Most of the video observation results show a decrease in the duration of RB from pre- to post-exercise, suggesting support for the first hypothesis. However, there was an increase in the total duration of RB throughout the program. There was a large variation in how specific RB changed. A program longer in duration may be required to track any consistent changes in those RB that occurred less frequently. Regarding Reese's pronounced eye squinting, I speculate that these movements occurred when he was resisting performing certain RB, and consequently performed several RB in rapid succession immediately afterwards. Thus, this behaviour may provide more context and understanding of Reese's RB.

The second hypothesis was not supported due to the increase in JHFT scores after exercising. When considering all of Reese's RB in relation to his JHFT scores, it appears that his task performance is not affected by the duration of RB. Specifically, there was a decrease in RB from pre- to post-exercise in most the sessions, yet his JHFT were consistently higher post-exercise.

The third hypothesis was not supported, due to the increase in total RBS-R score from pre- to post-intervention (from 10 to 51). The increase in most of these ratings (23 items) may be due to the support worker's involvement in the program which increased his understanding of RB. The support worker who rated the pre- and post-intervention RBS-R was involved in the program by: attending many exercise sessions, helping to motivate Reese during exercise, and asking questions regarding the program/the purpose of the study. In addition, Reese's biking performance was variable. This may suggest that he requires an exercise program with more sessions to gain a consistent performance on the bike.

Participant #4: 'Taylor'

Anecdotally, it appeared that Taylor enjoyed interacting with his volunteer and me. As he continued through the program he became more affectionate and attempted to hug me during a few of the sessions. When he was biking, Taylor would slow down or briefly stop pedalling if the volunteer or I was not focused on encouraging him to pedal fast, despite jogging on the spot next to him. For example, this occurred when I was addressing questions from his support worker while jogging next to him and when I went to take notes on his biking performance. Taylor engaged in a relatively few RB; his most frequent RB was *head turning/nodding*.

Taylor: Video Observation.

Video Observation Analysis: Overview. Table 9 provides a list of RB and descriptions that emerged from coding Taylor's video observation. Figure 19 shows the difference of all RB between the pre- and post-exercise video observations. Taylor displayed an increase in the duration of RB from pre- to post-exercise in the majority of sessions. Specifically, the duration of RB was greater post-exercise than pre-exercise in 10 sessions (pre- to post-exercise difference ranging from eight to 116 seconds), while the duration of RB was greater pre-exercise than post-exercise in six sessions (pre- to post-exercise difference ranging from two to 112 seconds). Regarding the absolute values, Taylor displayed a reduction in the duration of RB exhibited in the middle of the program, from session six to 10 (see Figure 20).

Table 9

Taylor: List of RB

Type of RB exhibited	**Description of RB**
Mouth	- Placing hand on mouth - Tongue clicking
Rubbing Surfaces/Objects	- Using hands to rub table or objects
Object Interactions	- Tapping objects
Hand Movements	- Finger turning - Clapping - Quickly moving hand in a "stop position"
Body Movements	- Body-rocking - Torso Spinning: similar to body-rocking, involves sitting and swaying torso in a circular motion - Swings elbow out from side of body
Head Turning/Nodding	- Moving head in a vertical or horizontal direction
Contact with self	- Touching head or face - Slaps or rubs stomach

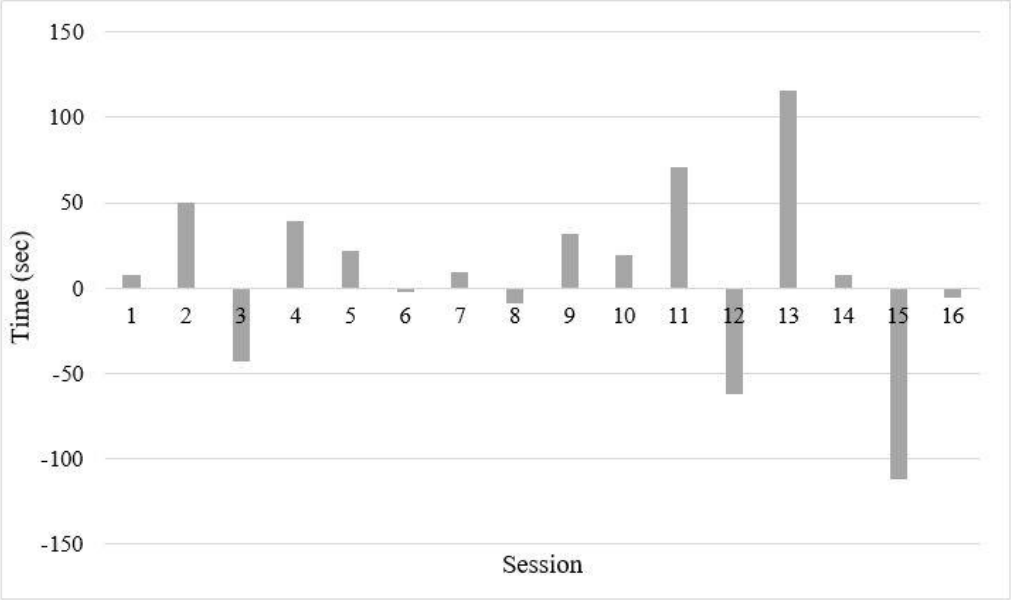


Figure 19. Taylor: The difference in time spent (in seconds) for all RB exhibited pre/post exercise.

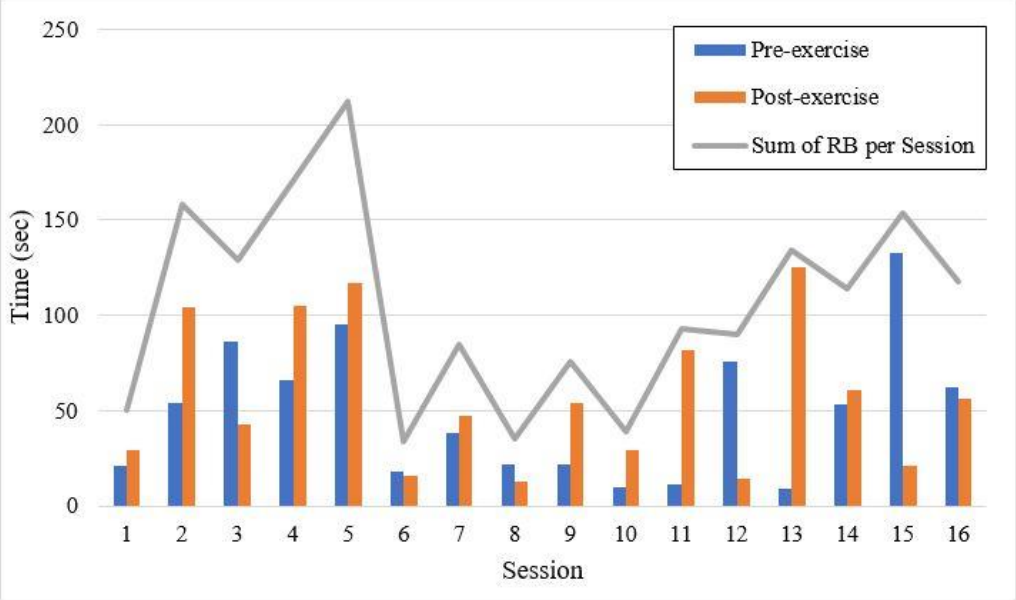


Figure 20. Taylor: The time spent (in seconds) for all RB exhibited pre/post exercise and per session.

Video Observation: Specific RB. For Taylor, *clapping*, *finger turning*, and *tapping objects* appeared less frequently during the program, except for large increases towards the end of the intervention (from sessions 14-16). The large increases for *clapping* and *finger turning* only occurred prior to, rather than after, exercise. Taylor engaged in *rubbing surfaces/objects* more frequently, but displayed a large increase in session 13. Figures 21-24 depict the duration of RB pre/post exercise and per session for each of the RB that displayed these large increases. Taylor engaged in *tapping objects* and *sticking elbow out* RB more often prior to exercise, while *rubbing surfaces/objects* and *head turning/nodding* occurred more frequently after exercise. *Head nodding/turning* and *sticking elbow out* did not display an overall change in duration throughout the program (see Appendix S). Two closely related RB (body-rocking and

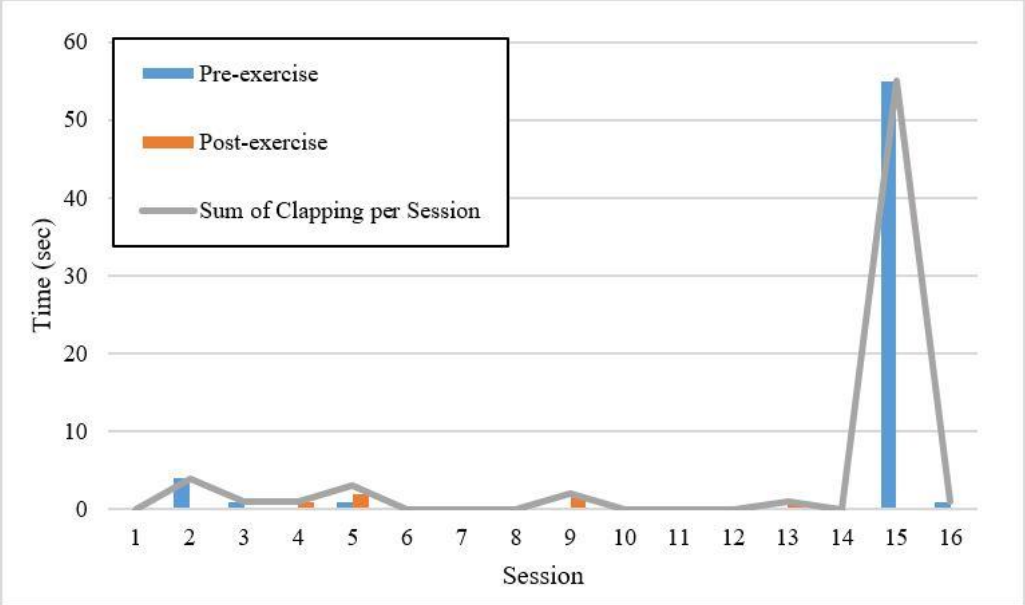


Figure 21. Taylor: The time spent (in seconds) for *clapping* RB exhibited pre/post exercise and per session.

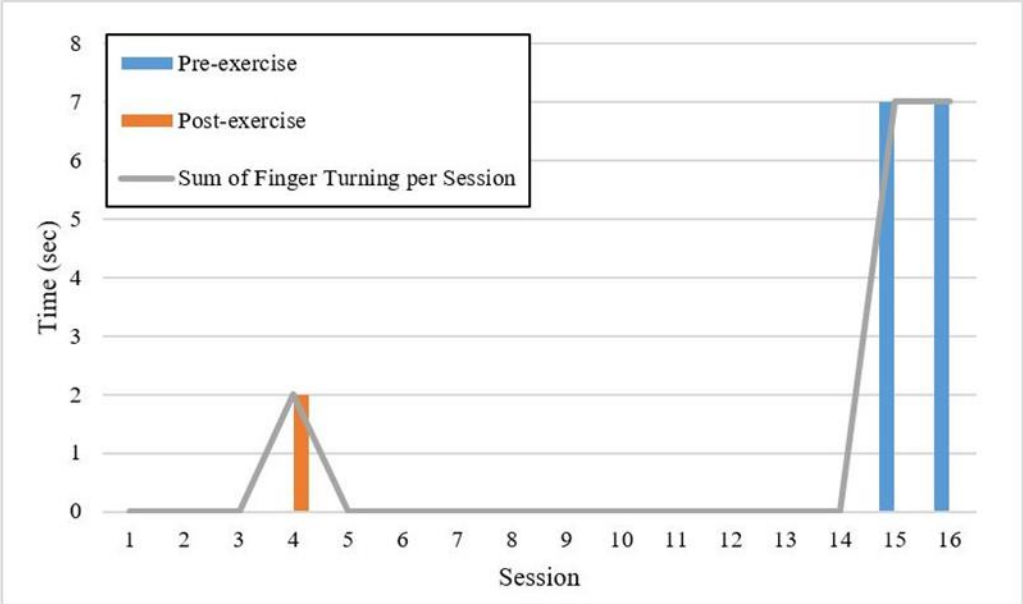


Figure 22. Taylor: The time spent (in seconds) for *finger turning* RB exhibited pre/post exercise and per session.

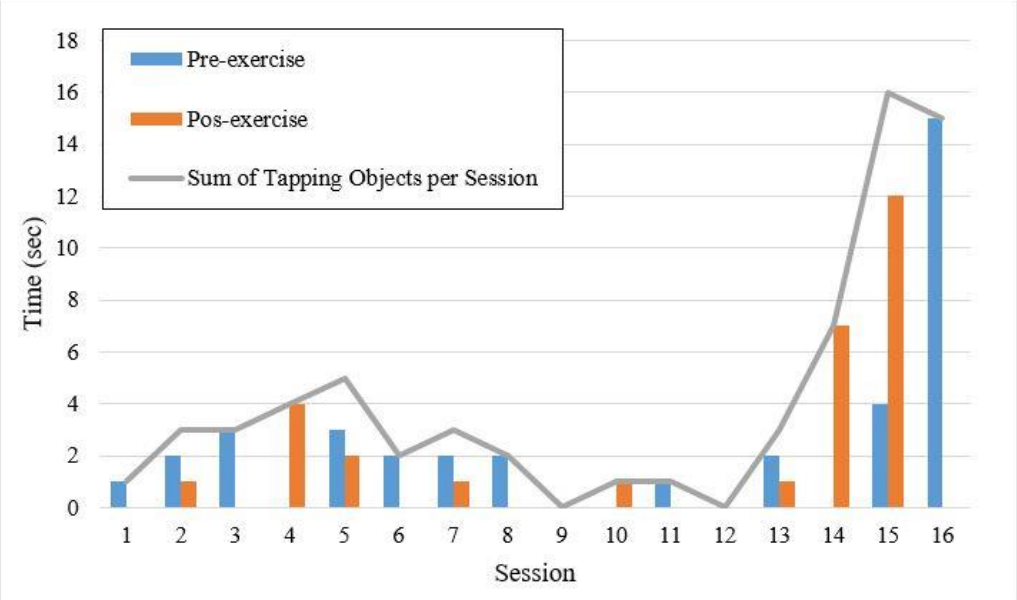


Figure 23. Taylor: The time spent (in seconds) for *tapping objects* RB exhibited pre/post exercise and per session.

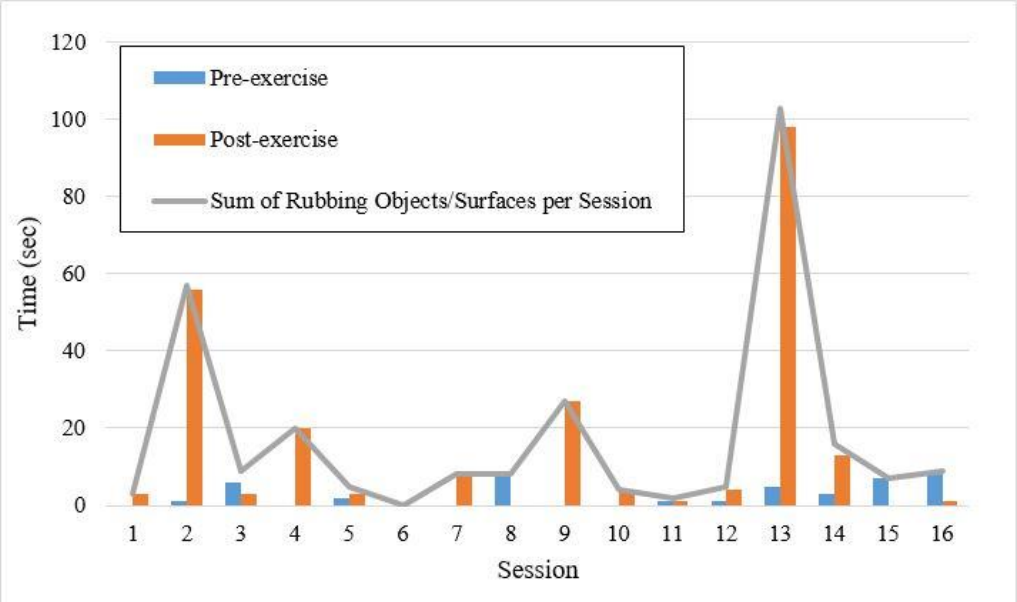


Figure 24. Taylor: The time spent (in seconds) for *rubbing surfaces/objects* RB exhibited pre/post exercise and per session.

torso spinning) displayed a decrease in duration throughout the program and occurred more frequently pre- versus post-exercise (see Figure 25).

Vocalizations were not tracked for all participants due the difficulty associated with coding. However, Taylor presented two vocalizations that were distinct and short in duration. One vocalization was a very quick, high-pitched noise while the second was a lower-pitched noise that resembled air being forced out quickly by flexing the abdomen. Figure 26 illustrates the extent to which these decreased during the program. These vocalizations were not included in the sum of all RB (i.e., Figures 19 and 20) because this type of behaviour was excluded for the other participants.

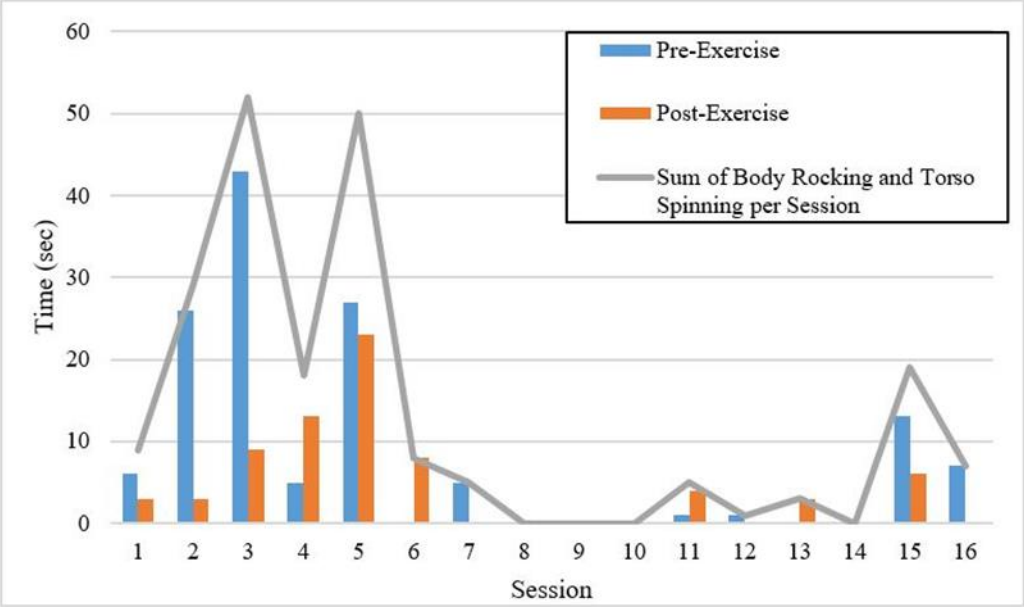


Figure 25. Taylor: The time spent (in seconds) for *body-rocking* and *torso spinning* RB exhibited pre/post-exercise and per session.

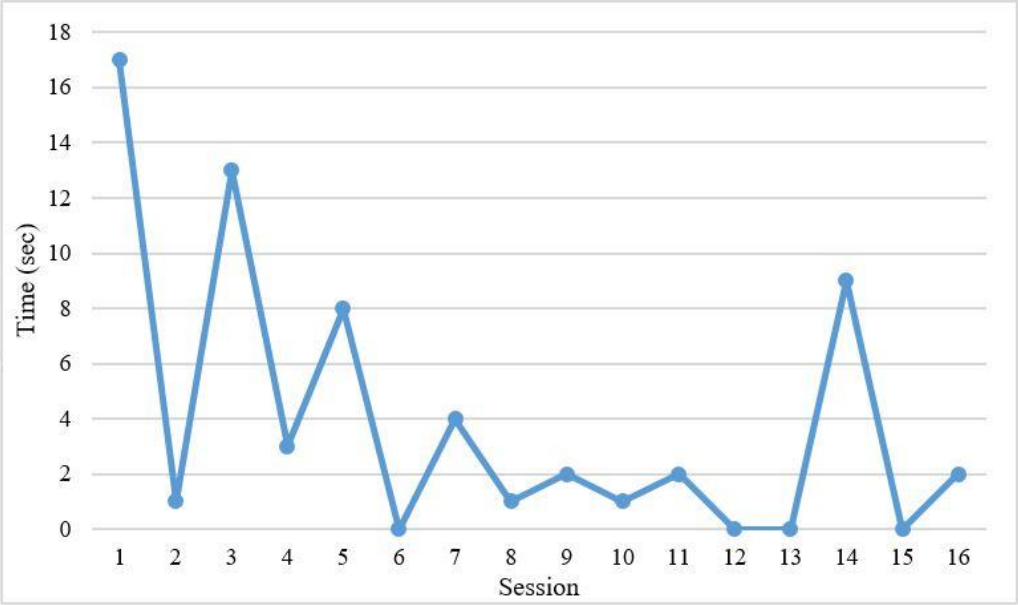


Figure 26. Taylor: The time spent (in seconds) engaged in high- and low-pitched vocalizations per session.

Taylor: JHFT Performance. Figure 27 depicts the percent difference results comparing pre- to post-exercise JHFT scores. The percent differences range from -23.4% to 26.7%. Overall, no consistent trend emerged.

Taylor: RBS-R. The total score for pre-intervention RB severity was 20 and post-intervention it was 13. Table 10 provides Taylor's pre- and post-intervention results for the five subscales. The total score for *stereotypic* and *ritualistic/sameness behaviour* subscales decreased, *compulsive behaviour* and *restricted interest behaviour* increased, and the *self-injurious* subscale stayed the same. Within the five subscales, three items increased and 11 items decreased in RB severity. Regarding the *stereotypic behaviour* subscale (rated by his mother) the item for *whole body* (body-rocking and body swaying) increased (zero to one), while my video observations suggested a decrease. The *locomotion* item (turns in circles, jumps) decreased (two to zero), although no *turning in circles* or *jumping* RB were exhibited in the videos.

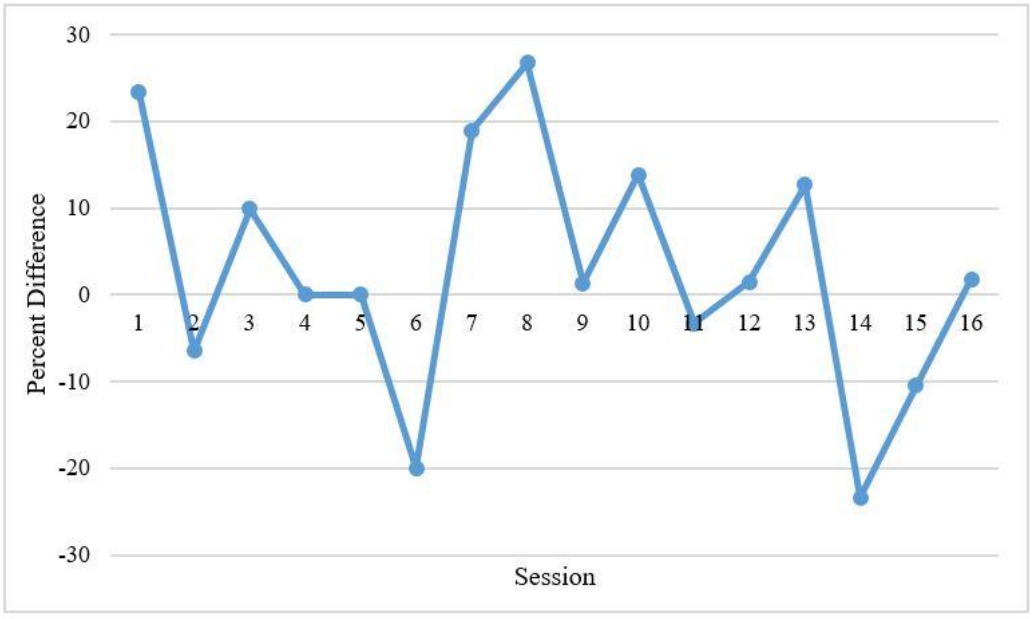


Figure 27. Taylor: The percent difference of the JHFT scores between pre- and post-exercising.

Table 10

Taylor: RBS-R results

RBS-R Subscales	Pre-Intervention	Post-Intervention
Stereotypic Behavior*	9	3
Self-Injurious Behavior*	1	1
Compulsive Behavior	1	2
Ritualistic/Sameness Behavior	8	6
Restricted Interests	1	1

*subscale contained items that were tracked by video observations

The item *hand/finger* movements decreased (two to one), while the video observations suggested an increase in *finger turning* occurred at the end of the program. Similarly, the *tap/touch* item stayed at a rating of one, and the video observations displayed an increase in tapping objects late in the program. The item for *head movements* decreased, while the video observations showed no consistent trend. Additionally, the item for *object usage* (spins or twirls objects, throws objects) decreased, but did not appear in the video observations. With respect to the *self-injurious* subscale, the *skin pricking* item stayed at a rating of one pre- to post-intervention, but did not appear in the video observations.

Taylor: Biking Performance. Taylor's average level of METs per exercise session ranged between 1.3 and 3.4, with an overall average of 2.0. Taylor exercised at a moderate level of intensity (3-6 METs) 17.5% of the time and did not reach a vigorous level of intensity for any of the sessions. In addition, Taylor did not complete the full 20 minutes of biking on four of the exercise days. These days ranged from completing 13 to 18 minutes of exercise. Three of these days seemed to be related to a change in Taylor's sleep medication. The support worker indicated at the first session, that he had stopped taking one of his sleeping medications, and he only exercised 14 minutes that day. Moreover, Taylor exercised 18 and 13 minutes at sessions eight and nine, respectively,

which occurred a week after the addition of a sleeping medication (noted at session six). Taylor's support worker mentioned that he was drowsy during session nine.

Interpretation and Summary of Taylor's Results. Since most of the video observations displayed an increase in RB from pre- to post-exercise, the first hypothesis was not supported. In addition, Taylor displayed a reduction in the duration of all RB exhibited in the middle of the program, from session six to 10 (see Figure 20). This reduction in RB may be related to a change in sleep medication, which Taylor's support worker reported at the sixth session. The specific type of medication was not provided. Four of Taylor's RB displayed an increase towards the end of the program. However, two RB from the video observations (body-rocking and torso spinning) decreased in duration throughout the program (see Figure 25). This may suggest that, for Taylor, a minimal amount of moderate intensity biking might have been enough to reduce these RB.

Since there was no observable trend in JHFT scores, the second hypothesis of an improvement in task performance was not supported. The third hypothesis was supported by the decrease in total score for the RBS-R. However, there are differences between the *stereotypic behaviour* subscale and the video observation results. With regards to biking performance, Taylor consistently exercised at a light-to-moderate intensity and was unable to complete the full 20 minutes of biking on four days. The changes to Taylor's sleeping medication may have affected his biking performance on three exercise days and it is unclear to what extent his RB were influenced.

Participant 5: 'Max'

Max appeared to enjoy interacting with the support worker, the volunteer, and me. He displayed several RB and frequently paced within the exercise room. Max also engaged in many unique RB such as dancing (described below). He attended 10 sessions, however due to difficulty with completing the biking portion of the study he successfully completed only five of those sessions (a completed session involved a minimum of 10 minutes of biking). During the program, Max displayed some aggressive behaviours which was an exclusion criteria for the current study. Despite the appearance of being happy to attend the program, Max indicated that he did not want to exercise on the last session. In addition to the aggressive behaviour, this led to Max being removed from the program early. The acute changes in RB from the video observation and the JHFT scores were not be included in Max's results due to the limited number of completed sessions.

Max: Video Observation.

Video Observation Analysis: Overview. Table 11 provides a list of RB and descriptions that emerged from coding Max's video observations. Figure 28 displays both incomplete (marked with an INC next to the session number) and complete exercise sessions. The incomplete exercise days only have pre-exercise results with the exception of session 'two INC', which has both pre- and post-exercise results. When examining the pre-exercise results between incomplete and complete exercise sessions, there were no distinct differences. Similarly, there was no general change in RB when examining only the completed exercise days. Overall, it was difficult to determine a trend with the sum of all RB for pre- and post-exercise due to the reduced number of completed exercise sessions.

Table 11

Max: List of RB

Type of RB exhibited	**Description of RB**
Rubbing Surfaces	- Using hands to rub table or objects; includes touching/rubbing wall surfaces
Object Interactions	- Tapping/slapping with flat hand on objects - Using an object to tap other items - Shaking an object
Hand Movements	- Clapping - Pressing hands together without making a 'clapping' noise
Body Movements	- Body-rocking - Pacing - Spinning while standing or during pacing - Hopping or jumping
Contact with self	- Touching head or face - Rubbing or tapping a body part (i.e., wiping top of pants) - Slapping or hitting one's self (open or close fist)
Contact with another	- Reaching towards another individual or holding another's hand/shoulders. - Placing hands on the cheeks of another's face
Dancing	- Involves interlacing fingers with another individual while squeezing hands and pushing against person to rock back and forth (as described by Max's support worker)
Close face/Staring	- Typically performed in between pacing. Involves stopping abruptly and in close proximity to the face of the primary researcher, volunteer, or support worker. May stay in close proximity for a number of seconds.
Hand behind back and pressed against a wall	- Placing back of hand on the lumbar region of the back, fingers gathered to a point and pressed against the wall
Leg Movements	- Stomping foot or kicking leg out - Heel of one foot tapping the toes of the other foot
Auditory	- Covering ears by placing hands over top or by folding tops of ears downward and holding them

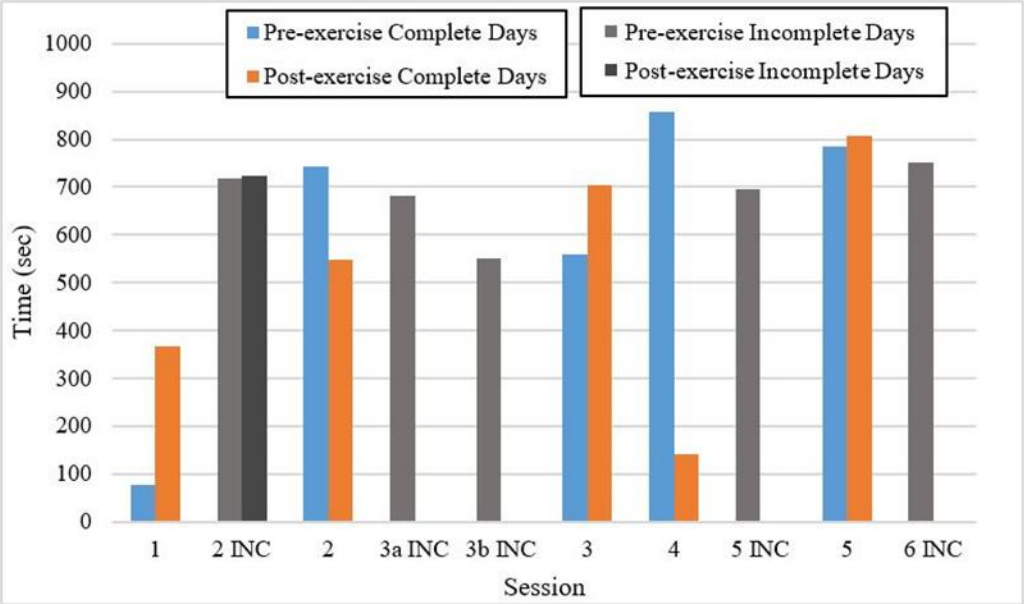


Figure 28. Max: The time spent (in seconds) for all RB exhibited pre/post-exercise for incomplete and complete exercise days.

Video Observation: Specific RB. The duration of RB was compared between the incomplete and complete exercise days. Figure 29 shows Max engaging in *hand behind back and pressed against a wall* RB more frequently on completed versus incomplete exercise days. No other trends emerged from his other RB.

Max: RBS-R. The total score for both pre- and post-intervention RB severity was 10. Table 12 provides Max's pre- and post-intervention results for the five subscales. The severity rating for the *stereotypic behaviour* subscale decreased; *self-injurious* subscale increased; and *compulsive*, *ritualistic/sameness*, and *restricted interests* subscales stayed the same. Within the five subscales, two items increased and three items decreased in RB severity.

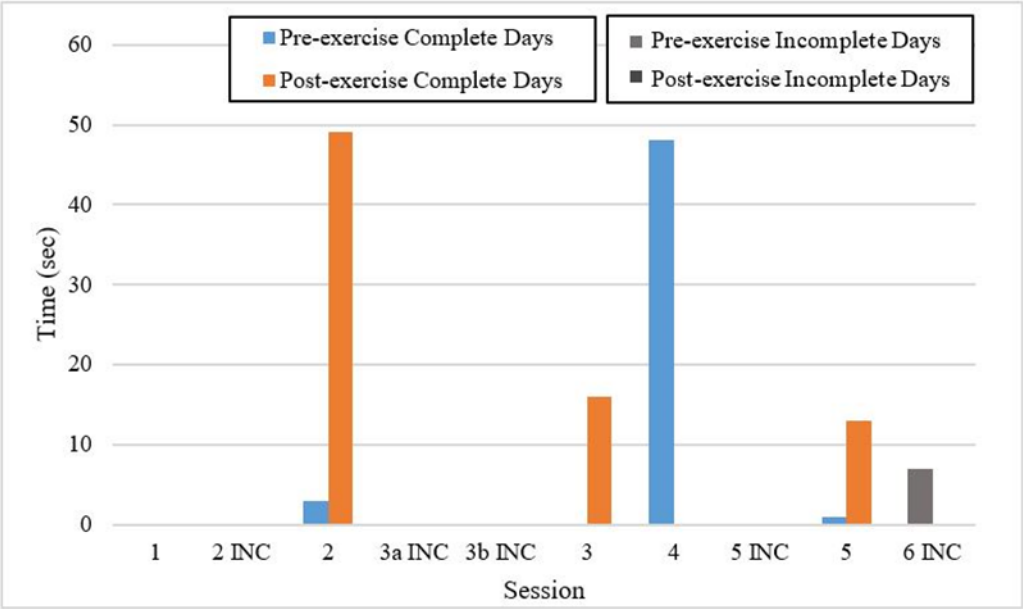


Figure 29. Max: The time spent (in seconds) engaging in *hand behind back and pressed against a wall* RB pre- and post-exercise for incomplete and complete exercise days.

Regarding the *stereotypic behaviour* subscale, the severity rating for three items decreased: *whole body* (from two to zero), *hand/finger movements* (one to zero), and *object usage* (three to zero). In addition, one item increased in severity: *tap/touch* objects, surfaces, or people (from zero to three). Furthermore, one item from the self-injurious subscale, *rubs or scratches self*, increased in severity from a rating of zero to one. The items of the *stereotypic behaviour* and *self-injurious* subscales were not compared to the specific RB from the video observations results due to the lack of completed exercise sessions, thus Max does not have a chart comparing the items in the RBS-R to his RB from the video observations in Appendix R.

Table 12

Max: RBS-R results

RBS-R Subscales	Pre-Intervention	Post-Intervention
Stereotypic Behavior*	10	9
Self-Injurious Behavior*	0	1
Compulsive Behavior	0	0
Ritualistic/Sameness Behavior	0	0
Restricted Interests	0	0

*subscale contained items that were tracked by video observations

Max: Biking Performance. Max's average MET results on the completed exercise days ranged from 1.5 to 4.4. He completed 13 minutes of exercising on session three. On session two, four, and five the BODYMEDIA® armband tracked an extra four to 16 minutes due to Max stepping off the bike several times to pace/run before returning. Thus, the average METs for session two to five are influenced by the addition of pacing time. Max had difficulty biking and alternative forms of exercise, which were similar to the warm-up exercises (jumping jacks and running within the room provided) were attempted but were not successful.

Interpretation and Summary of Max's Results. The first hypothesis, a decrease in RB after exercising, and the second hypothesis, a decrease in JHFT scores following exercise, could not be evaluated due to the lack of completed exercise days. One repetitive behaviour, *hand behind back and pressed against a wall*, occurred more often on days that Max was willing to complete exercise. Similarly to Morgan's *in front of face hand movements*, Max's *hand behind back and pressed against a wall* may indicate a positive mood. The third hypothesis, a reduction in RB severity, was not supported due to the same pre- and post-intervention total scores. When Max's RBS-R total scores (rated by his support worker) was compared to my video observation results, one would expect a higher rating of severity in the stereotypic behaviour subscale due to

the high durations of RB Max exhibited during the video observations. Max exercised at a variable rate and stopped pedalling/stepped off the bike frequently which may have altered his average MET results.

Despite the lack of completed exercise sessions, Max's experience as a participant did provide valuable information. A biking program may not be beneficial for everyone. Max's RB, in particular *pacing*, might have interfered with his ability to bike continually. Additionally, Max may have been confused as to the correct motions on the bike because he often tried to pedal backward. Since Max was having difficulty with biking, I tried to implement exercises that were similar to his warm-up routine (i.e., running and jumping jacks). Additionally, I had previously seen Max run/jump and thought these exercises would be a viable alternative to biking, but this was not the case. Max's support workers mentioned that he preferred jumping on a mini-trampoline and running within an enclosed park. Unfortunately, these forms of exercise could not be implemented within the current study. Thus, Max may need to run and exercise at his own pace or use a different form of aerobic exercise. Engaging in exercise for shorter durations and more frequently throughout the day may also be beneficial for Max. Overall, Max is an important example for support workers interested in implementing exercise, as flexibility with the tools/equipment provided as well as the duration and frequency of exercise are likely required.

Participant #6: 'Sam'

Sam was a reserved individual who talked in a very soft voice, and sometimes engaged in self-talk. He never rushed to compete any of his tasks and appeared happy during the program. Throughout our sessions, Sam increased in his willingness to listen

to my suggestions regarding biking. Overall, he engaged in a limited number of RB; his most frequent RB was *straightened objects*.

Sam: Video Observation.

Video Observation Analysis: Overview. Table 13 provides a list of RB and descriptions that emerged from coding Sam's video observations. Figure 30 displays the difference in the time spent engaging in all RB between the pre- and post-exercise video observations. Sam displayed a decrease in the duration of RB in the majority of the sessions immediately after exercising. Specifically, the duration of RB was greater pre-exercise than post-exercise in 11 sessions (pre- to post-exercise difference ranging from two to 65 seconds), while duration of RB was greater post-exercise than pre-exercise in five sessions (pre- to post-exercise difference ranging from three to 266 seconds). The duration of all RB per session decreased throughout the program (see Figure 31). Specifically, sessions 11 to 16 stayed below 100 seconds of RB per session.

Table 13

Sam: List of RB

Type of RB exhibited	**Description of RB**
Rubbing/Scratching Surfaces/Objects	- Using hands to rub or scratch table/object surfaces
Object Interactions	- Tapping objects - Fixing object position by stacking and straightening objects
Contact with self	- Wiping or touching face - Fixing hair: brushing hair back and off shoulders, even if previously pushed back

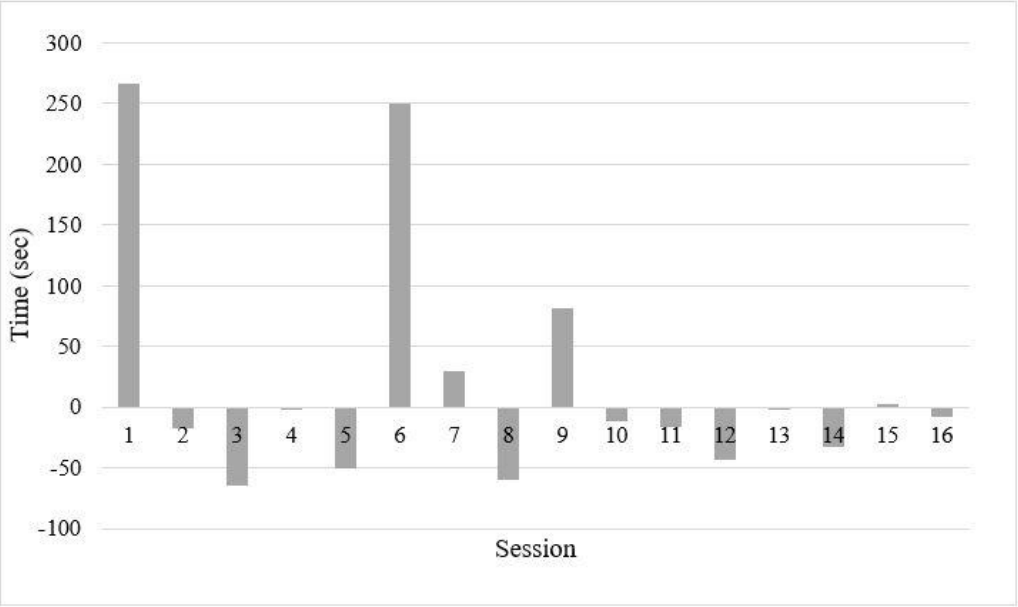


Figure 30. Sam: The difference in time spent (in seconds) for all RB exhibited pre/post exercise.

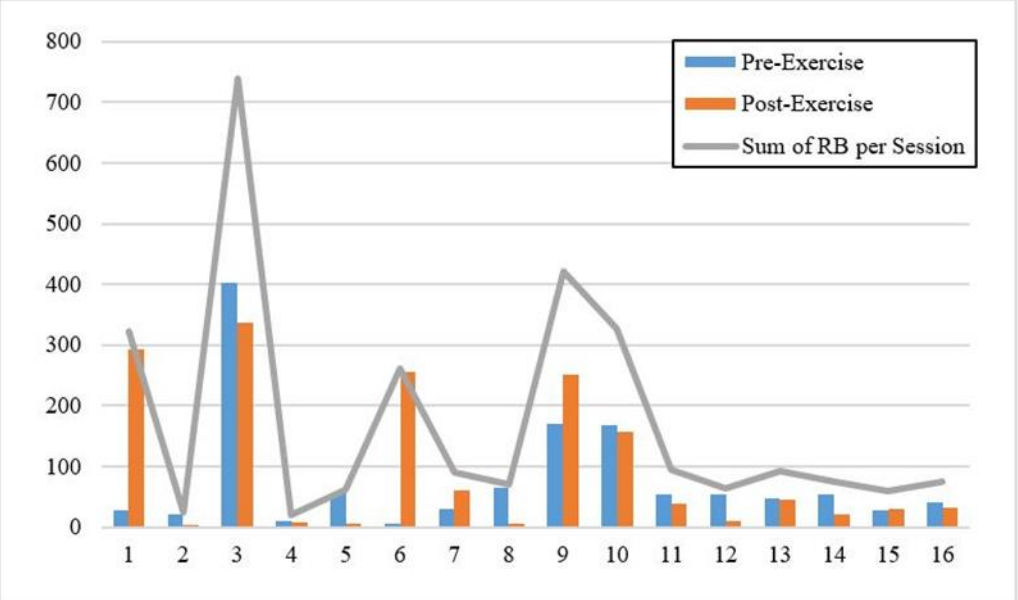


Figure 31. Sam: The time spent (in seconds) for all RB exhibited pre/post exercise and per session.

Video Observation: Specific RB.

Sam most frequently displayed *fixing object position* and *rubbing surfaces/objects* RB. Both of these RB were variable during the first half of the program, with an increase at session nine, followed by a decrease from sessions nine to 11, and stayed at a low duration from sessions 11 to 16 (see Figure 32). *Fixing hair* RB displayed similar variability in the first half of the program, but decreased gradually from session 10 to 16 (see Figure 33). Within the first half of the program, post-exercise values for *fixing hair* were higher than pre-exercise values. This trend reversed in the second half of the program and was accompanied by a decrease in overall duration (see Figure 33). *Wiping/touching face* and *tapping objects* did not occur frequently enough to yield any trends.

Sam: JHFT performance. Figure 34 depicts the percent difference results comparing pre- to post-exercise JHFT scores. The percent difference range from -9.1% to 13%. Overall, no consistent trend emerged.

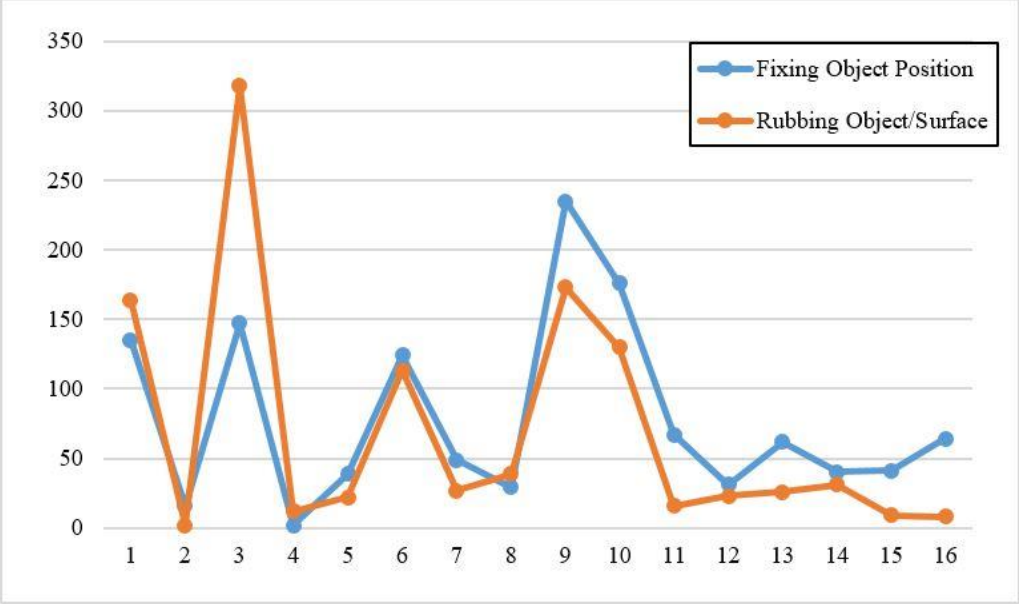


Figure 32. Sam: The time spent (in seconds) on *fixing object position* and *rubbing surfaces/objects* RB per session.

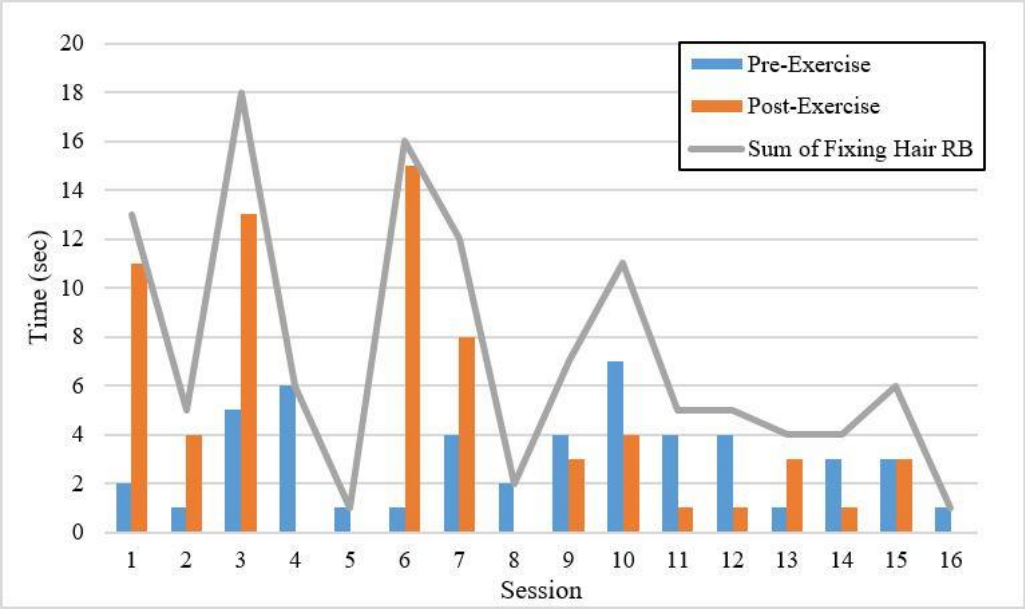


Figure 33. Sam: The time spent (in seconds) for *fixing hair* RB pre/post-exercise and per session.

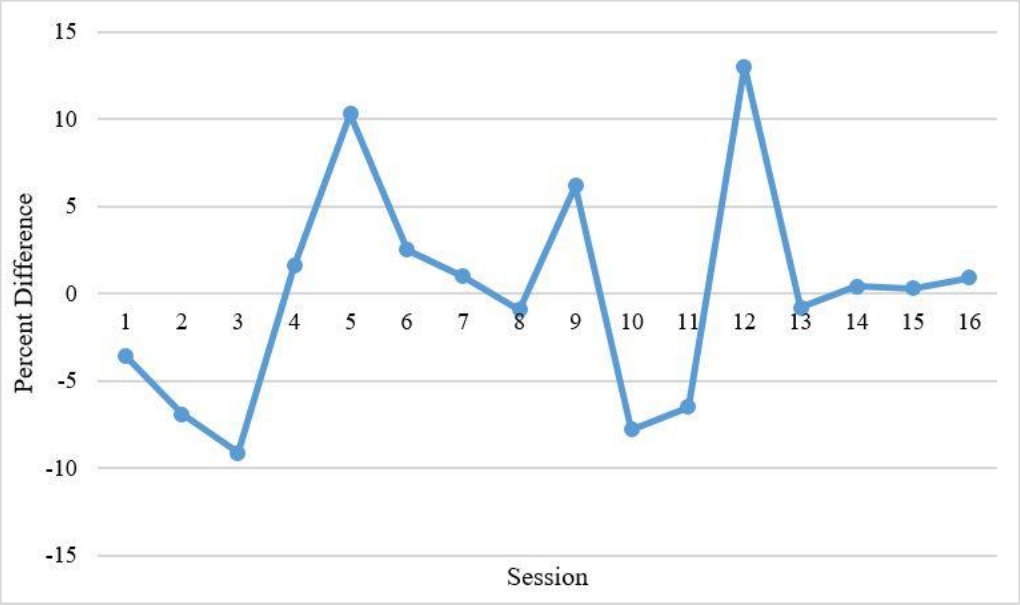


Figure 34. Sam: The percent difference of the JHFT scores between pre- and post-exercising.

Sam: RBS-R. The total score for pre-intervention RB severity was 34 and post-intervention was 36. Table 14 provides Sam's pre- and post-intervention results for the five subscales. The total score for *stereotypic* and *self-injurious behaviour* subscales increased, *ritualistic/sameness behaviour* and *restricted interests* stayed the same, and *compulsive behaviour* decreased. Within the five subscales, nine items increased and eight items decreased in RB severity.

Within the *stereotypic behaviour* subscale, Sam's support worker rated the severity rated the *head* item (rolls, nods, or turns head) pre- versus post-intervention stayed the same (rating of one). However, head movement RB were not exhibited during my video observations. In addition, the *locomotion* item (turns in circle, jumps, etc.) increased (zero to one) but was not observed in the video observations. The *sensory* item stayed at a rating of two pre- to post-intervention and the severity of the item *touch/tap* increased (zero to one). Note that *rubbing surfaces/objects* could be an example for both the *sensory* and *touch/tap* items. The results from my video observations suggest that *rubbing surfaces/objects* increased throughout the program, which does not fit the changes indicated by the *sensory* and *touch/tap* items. Another RB associated with the *touch/tap* item is *tapping objects* and this RB did not occur frequently enough in my video observations to suggest an increase. With regards to the *self-injurious* subscale all

Table 14

Sam: RBS-R results

RBS-R Subscales	Pre-Intervention	Post-Intervention
Stereotypic Behavior*	6	8
Self-Injurious Behavior*	3	4
Compulsive Behavior	11	10
Ritualistic/Sameness Behavior	12	12
Restricted Interests	2	2

*subscale contained items that were tracked by video observations

items that were rated (*pulls, rubs or scratching self*, and *skin pricking*) did not appear in the video observations that I conducted.

Sam: Biking Performance. Sam's average level of METs per exercise session ranged between 1.4 and 1.6 with an overall average of 1.5. Sam did not reach a moderate or vigorous level of intensity and engaged in light exercise 78.8% (1.5-3.0 METs) of the time. It is important to note that on the fifth session, 21 minutes of light exercise were recorded due to Sam stepping off the bike and walking around the exercise room for one minute before returning to biking. This may have altered average MET values for that day. Despite a low MET level, Sam showed a gradual increase from one minute of light exercise per session, to frequently reaching 20 minutes of light exercise per session over the course of the program (see Figure 35).

Twenty minutes of light exercise may be the most Sam was capable of achieving without further training. Halfway through the program, I noted that he seemed to have difficulty taking in deep breaths. Deep breathing exercises were added into his warm-up

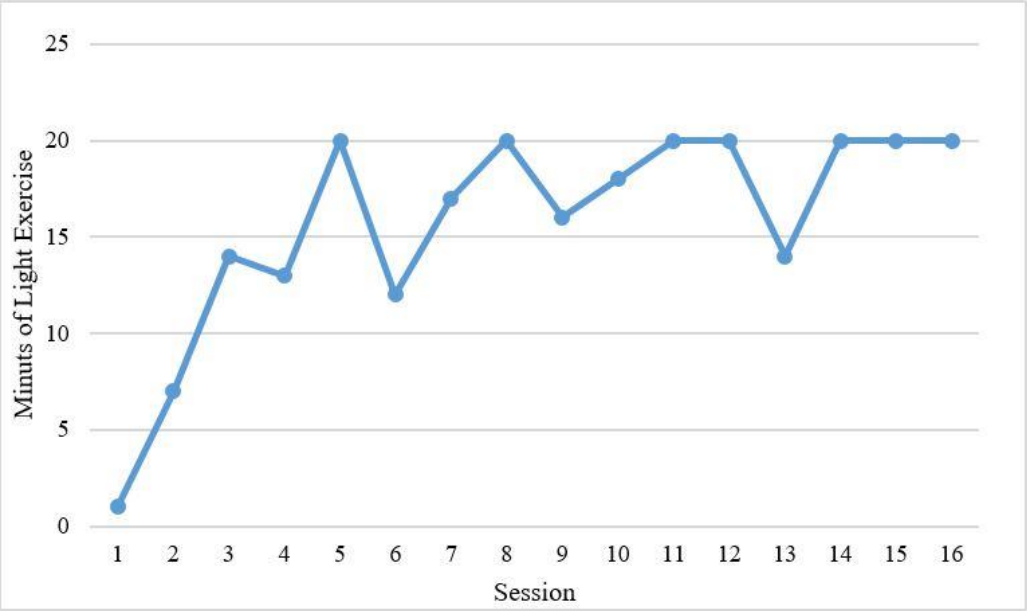


Figure 35. Sam: Minutes of light intensity exercise per session.

exercises on the ninth session. This involved describing and demonstrating how to inhale and exhale deeply. Sam persisted to have difficulty inhaling deeply and would often exhale twice in a row to mimic the breathing sounds I demonstrated. Additionally, I noted an appearance and increase in yawning while biking in sessions 11 to 15. On session 16, Sam seemed to inhale better during the warm-up practices, did not exhibit any yawning while biking, and achieved a higher MET value.

Interpretation and Summary of Sam's Results. Most of the results from the video observations showed a decrease in RB from pre- to post-exercise, suggesting support for the first hypothesis. Despite the variable results from the first half of the program, the sum of all Sam's RB show a decreasing trend. Three of his RB displayed a decrease in duration and two RB were not exhibited enough to infer a trend. Since there was no observable trend in JHFT scores, the second hypothesis of an improvement in task performance was not supported. The third hypothesis was not supported due to the increase in total score in the RBS-R.

Regarding biking performance, Sam exercised between a sedentary and light exercise intensity. The increase in yawning, and reaching only a light level of exercise intensity suggested that breathing rate may have been a factor influencing Sam's exercise performance. Nonetheless, the days that Sam consistently engaged in light intensity exercise for 20 minutes paralleled the sustained drop in RB duration (session 11-16). Thus, Sam reaching 20 minutes of light exercise may be all he needs elicit decreases in RB.

CHAPTER 5 Discussion

Overview

The purpose of this study was to determine whether individuals with ASD and ID (1) exhibited fewer RB and for shorter durations immediately following a moderate-to-vigorous intensity aerobic exercise session, (2) showed an improvement in task performance immediately following each exercise session, and (3) exhibited a reduction in the severity of the RB after engaging in a number of exercise sessions. The results from three out of the six participants supported the first hypothesis. However, two of the three individuals displayed an increase in the total duration of RB throughout the program. The second hypothesis was rejected due to the lack of support by any of the JHFT results. In addition, one participant (Reese) consistently took longer to complete the tasks after exercising. The third hypothesis was supported by three of the participant's RBS-R scores, for whom a decrease in the overall RBS-R severity rating occurred pre- to post-intervention. Despite the lack of consistent support for the current study's hypotheses, important information emerged when further examining the results from each participant.

Case Study Methodology

This study differed from other studies examining the impact of exercise on the expression of RB in many ways, one of which was in the use of a case study methodology. Assessing each specific individual on their progress throughout the intervention provided important information. Each participant exhibited a unique set of RB, and there may have been interactions between different RB. For example, Dakota decreased in his *pacing* RB, which may have resulted in an increase in his *shaking*

objects RB. This interaction may not have occurred for other participants if they did not engage in *pacing,* or perhaps it was influenced by the appearance of another RB. This exemplifies why it is important to track all of the RB a participant exhibits. The practice-orientated case study methodology made it possible to track and examine each participant's RB and to describe important details about their progress throughout the intervention.

The meaning of certain RB might be different between individuals. For example, Morgan appeared to exhibit his *in front of face hand movements* as an expression of excitement, whereas Reese was happy to attend the program, but did not appear to use his i*n front of face hand movements* as an expression of excitement. This suggests that not all RB have a similar origin, and that some RB can be a form of positive expression. Furthermore, support workers, parents, or guardians may perceive some RB as negative or positive, and there is some research evidence to support this. Harrop, Gulsrud, Shih, Hovsepyan and Kasari (2015) assessed the interaction between 85 caregivers and their toddlers diagnosed with ASD during a 10-minute play time. The researchers found that caregivers responded less than half of the time to their toddler's RB. Additionally, the caregivers were more likely to respond and intervene when their toddler exhibited object use and visual RB versus verbal or motor RB. The researchers suggested that caregivers may perceive their interaction with their toddlers being affected by object use and visual RB (Harrop, et al., 2015). Since toddlers were preverbal, a caregiver may not have wanted to intervene with verbal attempts. More importantly, motor RB were exhibited during periods of high excitement, thus caregivers may have been reluctant to intervene. Boyd, Conroy, Mancil, Nakao and Alter (2007) assessed three children with ASD who

exhibited circumscribed interests on their social interactions with a peer who was typically developing. The results suggest that integrating circumscribed interests into play situations would facilitate their social interaction with a peer, such as utilizing an object that was associated with circumscribed interests during play time (Boyd et al., 2007). This demonstrates how RB can be beneficial for a person with ASD.

Understanding certain RB may help facilitate communication between the individual providing support and the person receiving support, especially for those who are non-verbal. For example, Max displayed his *hand behind back pressed against wall* RB on only the completed exercise days. This suggested that Max was interested in engaging in exercise and participating those days. This may be important information for his support workers to understand when Max is in a positive mood. Thus, researchers should try to understand the RB that are associated with communication or a positive mood and seek to identify and reduce specific RB that are deemed maladaptive, rather than attempting to decrease all RB.

Another benefit to the case study methodology is the ability to tailor the type of motivation used for each participant. This provided insight on how to implement different methods of motivation and suggestions for future exercise programs. An example motivation used was performing exercise myself. Specifically, once Morgan reached a certain speed while biking I would preform an exercise (typically a push-up). This method indirectly influenced the volunteer and the support worker to be more enthusiastic in their verbal encouragement. I believe that it provided the volunteer and support worker a reward for their efforts in cheering. However, it is important to note that the same motivational methods did not work for every exercise session. Thus,

techniques for increasing motivation needed to be rotated while exploring new methods that would work for each person. Additionally, Max's case study suggests that alternative methods of exercise may need to be provided, and the frequency and duration of exercise may need to be adjusted for each person. Appendix T provides a list of guidelines and suggestions for any individual intending to implement aerobic exercise for people with ASD and ID.

Overall, people with ASD and ID have a wide range of abilities and display unique sets of RB, which means group data (i.e., grouping participants or grouping RB) can potentially overlook important details about each participant. Oliver Sacks described the importance of restoring the human subject to the center, instead of their pathology, and that an individual's 'personhood' cannot be disconnected from understanding their disease (Sacks, 1998). Although the current study did not develop a history of the participant prior to the intervention, the case study methodology allowed me to focus on each individual's unique set of RB and their progress throughout the program, which allowed a much more detailed analysis and a deeper understanding of their results.

Video Observations: Comparison to Literature

Another difference between this study and earlier studies is in the manner in which RB were tracked during video observation. Whereas this study identified and tracked the duration of individual RB, several previous studies used a variation of an interval sampling method during observation periods to track changes in RB (e.g., Kern et al., 1984; Levinson & Reid, 1993; Watters & Watters, 1980). This method involved dividing an observation time into small intervals (e.g., 10 second intervals) and indicating whether or not RB occurred during each interval. Depending on the interval time chosen,

this method can both under and overestimate the actual time an individual engaged in RB. For example, an individual who periodically clapped at a certain interval may have similar results as another individual who frequently engaged in a variety of RB. In addition, tracking specific RB would be difficult to implement using the interval method. Thus, tracking individual RB benefited the current study because it allowed me to determine specific changes in RB expression that occurred pre-/post-exercise and throughout the intervention. In addition, this form of assessment raised questions regarding: (1) the kinds of interactions that can occur between certain RB, (2) if some RB are beneficial and can be a form of expressing positive moods, and (3) if the factors that influence RB (i.e., anxiety, motivation) are different for certain RB and if some factors are affected by exercise.

Within the literature a number of studies presented the interval sampling results as a percentage (Bachman & Sluyter, 1988; Celiberti et al., 1997; Kern et al., 1982; Powers et al., 1992; Prupas & Reid, 2001 Watters & Watters, 1980). The current study had calculated the percent difference between the pre- and post-exercise video observations for each session. However, I found that there were limitations to using this method. Percent differences could not be calculated on a single repetitive behaviour if it did not appear in the pre-exercise observation. In addition, percent difference calculations can result in large percent increases (e.g., 4000%) whereas percent decreases cannot go lower than -100%. Thus, the current study compared the pre- and post-exercise durations of RB in seconds by calculating the difference in seconds, which provided a more accurate representation of the participant's appearance of RB. Although I sought to use a method

that would allow me to compare my results to previous literature, the limitations in using the percent difference calculations resulted in removal from the current study.

Although calculating the difference in seconds between pre- and post-exercise was more representative, those results only provide immediate changes in RB and may not represent a change in the duration of RB throughout the program. For example, two participants (i.e., Morgan and Reese) displayed an immediate decrease in the duration of RB from pre- to post-exercise in the majority of their sessions, but the total duration of RB per session increased throughout the program. If the percent differences or the difference in seconds calculated were the only results presented, then their RB might be misinterpreted as consistently decreasing. Thus, the current study used both the difference in seconds immediately pre- to post-exercise and the total duration of RB throughout the program. Therefore, the decisions to use a case study methodology and to avoid the interval sampling method and percent difference calculations allowed me to conduct an in-depth analysis in a manner that clearly extends the previous literature.

JHFT: Overview of Results

With the exception of Max (who completed five exercise sessions), the expression of RB did not appear to affect JHFT scores. The reason for this may be due to the short duration of the subtests. The JHFT was initially chosen for the current study because it was easy to administer to individuals with various levels of hand functioning, involved tasks that are similar to activities of daily living, and test-retest reliability was established for this population (Carr, et al., 2015; Jebsen, et al., 1969; Lynch & Bridle, 1989). Nonetheless, if tasks that are short in duration are not influenced by RB, then this may be beneficial in an employment setting. Specifically, if larger jobs can be divided into

smaller tasks that are manageable, then this may have important implications for people with ASD and ID in employment settings.

RBS-R: Overview of Results

The RBS-R was chosen for the current study for the following reasons: it could be easily administered to a parent or guardian, was a suggested assessment of treatment outcomes, had fair-to-good inter-rater reliability, encompassed a wide variety of RB, and indicated if a repetitive behaviour does not occur (Bodfish, Symons, & Lewis, 1999; Bodfish et al., 2000; Honey, Rodgers & McConachie, 2012; Lam & Aman, 2006). Despite the extensive rationale for choosing the RBS-R, the use of this scale may be questioned due to: (1) inconsistencies between the items rated and specific RB results from the video observations, (2) the differences between the total score to the overall presentation of RB in the videos, and (3) the discrepancies between number the of items rated from pre- to post-intervention.

The result sections for each participant outlined the discrepancies between the video observations and the *stereotypic/self-injury* subscales scores. In addition, Appendix R provides a complete comparison between the *stereotypic/self-injury* subscales items and the RB determined from my video observations. For the first concern regarding the RBS-R, some RB showed increases during the video observations throughout the program, whereas the corresponding RBS-R rating decreased, or vice versa. There are limitations when comparing the two measures because the video observations are only 16 minutes total per session and the presentation of behaviours may change throughout the day. Nevertheless, when a support worker or parent/guardian rated a RBS-R item as decreasing and my observations on the video data suggest an

increase in similar RB over the course of the program, it seems unlikely that the participant chose to engage in the majority of these RB exclusively during the video observations. Similarly, six pre-intervention items were rated as a zero (behaviour does not occur) when that RB occurred within the familiarization or first session and were displayed throughout the program. I believe that it is improbable that a particular repetitive behaviour developed or emerged at the start of the program. Although one could suggest that the RB may have appeared because they were anxious or excited, I would speculate that within the previous month prior to the intervention the support worker/guardian would have seen the participant when they were anxious or excited and would have observed the corresponding RB. In addition, it may be more likely for an individual to exhibit the same RB they have previously used in anxious or exciting situations, rather than developing new ones.

The second concern is that for some participants, the RBS-R total score is not representative of the number and duration of RB exhibited during the video observations. For example, Max exhibited an exceptionally high duration of RB throughout the videos, whereas his RBS-R total scores were rated very low (10 pre- and post-intervention). Taylor exhibited a noticeably lower duration of RB and was given a higher score (20 pre-intervention; 13 post-intervention) than Max. Finally, the support worker/guardian ratings for some items changed considerably from pre- to post-intervention. In particular, Reese's score, as determined by his support worker, increased in 23 items while decreasing in two with a total score of 10 pre-intervention and 51 post-intervention. Although my observations of the video data suggested a rise in the duration of Reese's

RB, the increase in 23 out of 38 items is a more drastic change than the videos would suggest.

A possible reason for the diverse responses in the RBS-R scores may be due to the support worker's or parent/guardian's understanding of what constitutes an RB. For example, Reese initially had his legal guardian fill out the RBS-R, who rated him below the inclusion criteria for the study (a rating of at least a two on a minimum of one item in the *stereotypic* subscale). Due to my experience working with Reese from a previous study, I knew he exhibited enough RB to meet the inclusion criteria. Reese's support worker was asked to fill out the pre- and post-intervention RBS-R, which qualified Reese to be a participant. This example raises the question as to whether certain individuals are able to appropriately assess RB. When reviewing the validation study for the RBS-R five-factor model (Lam & Aman, 2006), the parents/guardians were recruited from the South Carolina Autism Society (Lam & Aman, 2006), an organization which the authors noted as being" one of the leading sources of information and referral for individual with autism" (Lam & Aman, 2006, p.875). A potential limitation to the validity of the scale may be that the participants recruited were educated and aware of the various kinds of RB. While one might expect support workers to be aware of behaviours that would be defined as RB, not all parents/guardians will necessarily have this level of awareness pertaining to how RB are defined and be able to correctly identify behaviours as such. In addition, Harrop et al., (2015) stated that caregivers responded to less than half of RB exhibited by their toddlers and that motor RB were perceived as positive. This illustrates that a support worker or guardian may perceive certain RB as positive or beneficial. Thus, if certain RB are perceived as positive, a support worker or guardian may not rate

that behaviour as being severe on the item scale in the RBS-R. To review, I believe that the RBS-R scores may be influenced by a support worker or guardian's interpretation of the RB they witness, along with their previous knowledge of RB. Thus, it may be problematic to use the RBS-R results to assess the changes in RB severity in the current study.

In summary, the current study provided important information that adds to the literature on adults with ASD and ID. For instance, the current study explored a new method of analyzing RB from video observations which suggest that there is a unique set of RB for each individual. In addition, this method of analyzing videos uncovered limitations that may have arisen in previous methods. The results from the JHFT suggest that RB may not affect one's ability to perform tasks if they are short in length. Moreover, the current study questioned the use and validity of the RBS-R and how support worker, parent, or guardian perspectives may influence the results. Furthermore, this study provided guidelines and suggestions for individuals intending to implement aerobic exercise for adults with ASD and ID. Finally, the current study uncovered several questions that future literature should address. These questions include: (1) What are the kinds of interactions that can occur between certain RB? (2) Are some RB beneficial or a form of expressing positive moods and how should this be assessed? (3) Are the factors that influence RB (i.e., anxiety, motivation) different for certain RB and how are these factors are affected by exercise?

Overall, the assessment of specific RB and the case study format provided an interesting perspective on the impact of exercise on the expression of RB in people with ASD and ID. A recent article in Sports Illustrated described a number of individuals with

ASD who were participating and excelling in sport (Wertheim & Apstein, 2016). The article highlighted their unique characteristics, including their RB, as being a contributing factor to their success in sport. It seems that sport leagues and programs are learning how to embrace each person's unique characteristics, and perhaps research programs should take a similar approach.

Limitations

The limitations within the current study, that will be discussed in turn, pertain to (1) the video observations, (2) statistical analyses, (3) implementing exercise, (4) changes in the exercise room, and (5) staffing changes. First, the limitations within the video observations include: the duration of each video, the time after exercise, multiple RB occurring at once, the limited time allotted to RB, and the ability to see RB in the videos. Eight minutes of observation immediately after exercise was chosen to fit within the one-hour session for each participant, and previous research suggested that the largest decreases in RB occurred within the first 10 minutes post-exercise (Celiberti et al. 1997). However, due to the time constraints (i.e., the one-hour time limit per participant and the time needed for coding videos), increasing the observation time was not possible.

Within the videos, multiple types of RB sometimes occurred simultaneously. Since RB were tracked separately, in certain instances, the overall time recorded for engaging in RB was more than eight minutes. For example, if within five seconds an individual *paced* the entire time and also engaged in *in front of face hand movements* RB for three seconds, then eight seconds was recorded for the amount of time that individual engaged in RB. I chose this method because it allowed the time engaged in each repetitive behaviour to be tracked so that decisions of recording one behaviour over

another could be avoided. Additionally, I believe this method allowed a better representation of the intensity of RB during that time period. If I had only recorded five seconds of *pacing*, this would not have captured the full extent of that person's RB during that time. In addition, if a repetitive behaviour occurred, then the minimum duration allotted to that behaviour was one second. For instance, if a participant *clapped* once, it was tracked as *clapping* for one second.

During the videos, a participant may have moved to face away from the camera or walked out of view before the camera could be repositioned. During that period of time RB were unable to be tracked. This occurred relatively infrequently and did not affect the findings. Furthermore, certain RB could not be tracked by video, such as most higher-level RB (maintenance of sameness, circumscribed interests), and vocalizations. The current study focused on the changes in stereotypic behaviours, thus the inability to track higher-level RB did not have a significant impact. However, if exercise reduces anxiety, then it would be beneficial for future studies to explore methods of accurately tracking higher-level RB.

The second limitation was the statistical analyses for the current study. For example, a Spearman's ranked correlation was conducted for each participant on their durations of RB and their exercise performance. However, Spearman's ranked correlation assumes that the observations are independent (McDonald, 2014). Other methods of conducting a correlation that accounted for within subject measures were explored (i.e., Bland and Altman, 1995). However, this method provided a collective correlation and not correlations that were specific to each participant. Despite the inability to further analyze the data, conducting case studies provided advantages for

assessing specific RB and allowed for an accurate representation of the changes in the duration of RB by using the raw values.

The third limitation was that some participants would pedal at the pace they preferred, regardless of any form of motivation attempted. As a result, some participants were only capable of reaching low levels of exercise intensity. However, it was still important to include the low intensity exercise days. Sam showed reductions in RB from low intensity exercise.

The fourth limitation was that the exercise environment was altered due to room changes within Community Living of Essex County's facility. This may have been a factor for Morgan's performance because he would get distracted by reading magazines that were on bookshelves. To reduce this distraction, magazines were moved and/or a sweater was put over top of any writing before Morgan started biking. However, the choice to conduct data collection at CLEC facilities was made due to the familiarity the participants had with that location, which might have reduced any anxiety related to conducting the program in an unfamiliar place.

Finally, staffing changes caused a shift in many of the support workers involved in bringing certain participants to the program. Different support workers may have varying methods of interacting with the person they are caring for, which might have altered the participant's mood before entering a session. For example, one of Dakota's support workers, who was involved later in the program, mentioned at session 13 that she liked to play up-beat music for him during his car rides. Session 13 was one of the days that Dakota was overly excited and performed poorly while exercising. Although the cause of being overexcited is unknown, the music may have been a contributing factor.

On the other hand, Taylor exhibited a lot of loud vocalizations one day that a parent brought him to the program (which were different than the high and low-pitch vocalizations he usually made). However, Taylor's parent attended the program on another day and I did not note any additional loud vocalizations during that session. Changes to support worker staff which may have caused transportation adjustments were not anticipated due to the consistency experienced specific to these issues in previous exercise programs I was involved with. The impact of these changes is unknown, but future studies may benefit from controlling for these variables.

Future Directions

Researchers examining RB may want to create a profile of the RB each individual exhibits, which will help to determine which RB to target in an intervention. One method of determining which RB are positive and do not need to be targeted is by tracking the RB exhibited before and after providing something a person enjoys. In addition, if support workers, parents, or guardians do not notice certain RB, then perhaps those RB do not need to be reduced. Moreover, if some RB are an expression of a positive mood and increase during an intervention, then researchers may want to examine the relationship between forms of non-verbal communication and certain RB. One avenue could be exploring how gestures facilitate communication and if certain RB serve a similar purpose. Furthermore, it has been previously noted that anxiety is a factor influencing RB (Rodgers et al., 2012). Unfortunately, due to the hypotheses that were outlined, assessing anxiety fell outside the scope of this study. In addition to the suggestions outlined above, future programs developing a profile of behaviours might benefit from assessing the anxiety associated with each repetitive behaviour before

starting an intervention. Overall, developing effective ways of determining the purpose or the factors influencing RB may explain why some RB may decrease or increase within an intervention.

It should be noted that this study focused on a specific population and that the expression of RB might be different for people with ASD and without ID. A difference may occur due to varying IQ levels, where a lower IQ is associated with low-level RB and a higher IQ is related to higher-level RB (Bishop et al., 2006). Thus, recruiting individuals based on differing diagnoses may change the types of RB researchers assess.

Task performance in the current study was assessed by using subtests that were short in duration. Future studies should examine the effect of RB on tasks of longer duration. Moreover, future programs seeking to integrate people with ASD in employment settings should examine the effectiveness of breaking large jobs into smaller tasks to determine if this is a viable adaptation to an employee's environment.

Since many individuals with ASD have motor impairments and are at risk of health problems due to inactivity, finding ways to implement exercise is needed (Bhat et al., 2011; Fournier et al., 2010). Future exercise programs may need to adapt how a participant partakes in exercise by rotating different forms of activity or by implementing short 'bursts' of exercise throughout their daily routine. This method may help alleviate the limitations regarding motivation and getting participants to exercise at a higher level of intensity. Methods of motivation need to be adapted for each individual and to ensure they are improving their physical fitness. Anderson-Hanley et al. (2011) conducted two pilot studies using virtual reality (Dance Dance Revolution®; Dragon Chase®) to motivate participants to exercise. This avenue appears promising and more studies are

needed to assess the effectiveness and practicality of using virtual reality to motivate participants to exercise.

Conclusion

The increasing prevalence of ASD, and the effects of lifelong barriers, highlights the importance of interventions for people with ASD to improve their quality of life. (Murphy et al., 2005). The purpose of this study was to assess the effects of exercise in reducing RB immediately after a single session and over the course of several sessions, and its ability to improve task performance for adults with ASD and ID. Case studies were conducted with six adults who had a diagnosis of ASD and ID throughout an eight-week biking program. The video observations suggested the changes that occurred in RB were specific to each individual. In addition, analysis of the video observations suggested that there may be an interaction between certain RB, and that some RB are positive and do not need to be reduced. The JHFT scores were variable and, for most participants, RB may not influence the performance of short-duration tasks. Due to the variable results and discrepancies from the RBS-R, this scale was not a reliable measure of changes in RB severity in this study. Overall, the case studies conducted provided important information on each participant, their RB, and their progress throughout the program. The questions that were raised by the analyses of each person and the RBS-R suggested that changing the focus to decreasing some RB and embracing other RB for adults with ASD and ID is an important future direction.

REFERENCES

Ahrens, E. N., Lerman, D. C., Kodak, T., Worsdell, A. S., & Keegan, C. (2011). Further evaluation of response interruption and redirection as treatment for stereotypy. *Journal of Applied Behavior Analysis*, *44*(1), 95-108.

Ainsworth, B. E., Haskell, W. L., Whitt, M. C., Irwin, M. L., Swartz, A. M., Strath, S. J., ... & Leon, A. S. (2000). Compendium of physical activities: an update of activity codes and MET intensities. *Medicine and Science in Sports and Exercise*, *32*(9), 498-504.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington, VA: American Psychiatric Publishing.

Anderson-Hanley, C., Tureck, K., & Schneiderman, R. L. (2011). Autism and exergaming: effects on repetitive behaviors and cognition. *Psychology Research and Behavior Management*, *4*, 129.

Bachman, J. E., & Fuqua, R. W. (1983). Management of inappropriate behaviors of trainable mentally impaired students using antecedent exercise. *Journal of Applied Behavior Analysis*, *16*(4), 477-484.

Bachman, J. E., & Sluyter, D. (1988). Reducing inappropriate behaviors of developmentally disabled adults using antecedent aerobic dance exercises. *Research in Developmental Disabilities*, *9*(1), 73-83.

Bahrami, F., Movahedi, A., Marandi, S. M., & Abedi, A. (2012). Kata techniques training consistently decreases stereotypy in children with autism spectrum disorder. *Research in Developmental Disabilities*, *33*(4), 1183-1193.

Baranek, G. T. (1999). Autism during infancy: A retrospective video analysis of sensory-motor and social behaviors at 9–12 months of age. *Journal of Autism and Developmental Disorders*, *29*(3), 213-224.

Baruth, J. M., Casanova, M. F., El-Baz, A., Horrell, T., Mathai, G., Sears, L., & Sokhadze, E. (2010). Low-frequency repetitive transcranial magnetic stimulation modulates evoked-gamma frequency oscillations in autism spectrum disorder. *Journal of Neurotherapy*, *14*(3), 179-194.

Bhat, A.N., Landa, R.J., & Galloway, J.(2011). Current perspective on motor functioning in infants, children, and adults with autism spectrum disorders. *Physical Therapy*, *91*(7), 1116-1129.

Bishop, S. L., Richler, J., & Lord, C. (2006). Association between restricted and repetitive behaviors and nonverbal IQ in children with autism spectrum disorders. *Child Neuropsychology*, *12*(4-5), 247-267.

Bland, J. M., & Altman, D. G. (1995). Statistics notes: Calculating correlation coefficients with repeated observations: Part 1—correlation within subjects. *British Medical Journal*, *310*(6977), 446.

Bodfish, J. W., Symons, F. J., & Lewis, M. H. (1999). The repetitive behavior scale. *Western Carolina Center Research Reports*.

Bodfish, J. W., Symons, F. J., Parker, D. E., & Lewis, M. H. (2000). Varieties of repetitive behavior in autism: Comparisons to mental retardation. *Journal of Autism and Developmental Disorders*, *30*(3), 237-243.

Boyd, B. A., Baranek, G. T., Sideris, J., Poe, M. D., Watson, L. R., Patten, E., & Miller, H. (2010). Sensory features and repetitive behaviors in children with autism and developmental delays. *Autism Research*, *3*(2), 78-87.

Boyd, B. A., McBee, M., Holtzclaw, T., Baranek, G. T., & Bodfish, J. W. (2009). Relationships among repetitive behaviors, sensory features, and executive functions in high functioning autism. *Research in Autism Spectrum Disorders*, *3*(4), 959-966.

Boyd, B. A., McDonough, S. G., Rupp, B., Khan, F., & Bodfish, J. W. (2011). Effects of a family-implemented treatment on the repetitive behaviors of children with autism. *Journal of Autism and Developmental Disorders, 41*(10), 1330-1341.

Canadian Society for Exercise Physiology. (2002). Physical Activity Readiness Medical Examination. *www.csep.ca/forms.*

Cannella-Malone, H. I., Tullis, C. A., & Kazee, A. R. (2011). Using antecedent exercise to decrease challenging behavior in boys with developmental disabilities and an emotional disorder. *Journal of Positive Behavior Interventions*, *13*(4) 230-239.

Carr, K., McKeen, P., Daabous, J., Azar, N., Horton, S., & Sutherland, C. (2015). Reliability of the Jebsen Test of Hand Function among adults with autism and an intellectual disability. *Journal on Developmental Disabilities*, *21*(1), 52-60.

Carrasco, M., Volkmar, F. R., & Bloch, M. H. (2012). Pharmacologic treatment of repetitive behaviors in autism spectrum disorders: Evidence of publication bias. *Pediatrics*, *129*(5), 1301-1310.

Centre for Disease Control and Prevention. (2016). Prevalence and characteristics of autism spectrum disorder among children aged 8 years – autism and

developmental disabilities monitoring network, 11 sites, united states, 2012. *Morbidity and Mortality Weekly Report*, *65*(3), 1-23.

Celiberti, D. A., Bobo, H. E., Kelly, K. S., Harris, S. L., & Handleman, J. S. (1997). The differential and temporal effects of antecedent exercise on the self-stimulatory behavior of a child with autism. *Research in Developmental Disabilities*, *18*(2), 139-150.

Chen, Y. H., Rodgers, J., & McConachie, H. (2009). Restricted and repetitive behaviours, sensory processing and cognitive style in children with autism spectrum disorders. *Journal of Autism and Developmental Disorders*, *39*(4), 635-642.

Chugani, D. C., Chugani, H. T., Wiznitzer, M., Parikh, S., Evans, P. A., Hansen, R. L., ... & Rothermel, R. (2016). Efficacy of low-dose buspirone for restricted and repetitive behavior in young children with autism spectrum disorder: A randomized trial. *The Journal of Pediatrics*, *170*, 45-53.

Colcombe, S. J., Erickson, K. I., Scalf, P. E., Kim, J. S., Prakash, R., McAuley, E., ... & Kramer, A. F. (2006). Aerobic exercise training increases brain volume in aging humans. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences*, *61*(11), 1166-1170.

Conroy, M. A., Asmus, J. M., Sellers, J. A., & Ladwig, C. N. (2005). The use of an antecedent-based intervention to decrease stereotypic behavior in a general education classroom a case study. *Focus on Autism and Other Developmental Disabilities*, *20*(4), 223-230.

Cuccaro, M. L., Shao, Y., Grubber, J., Slifer, M., Wolpert, C. M., Donnelly, S. L., ... & Pericak-Vance, M. A. (2003). Factor analysis of restricted and repetitive

behaviors in autism using the Autism Diagnostic Interview-R. *Child psychiatry and Human Development*, *34*(1), 3-17.

Davis, C. L., Tomporowski, P. D., McDowell, J. E., Austin, B. P., Miller, P. H., Yanasak, N. E., ... & Naglieri, J. A. (2011). Exercise improves executive function and achievement and alters brain activation in overweight children: A randomized, controlled trial. *Health Psychology*, *30*(1), 91.

Dichter, G. S., Radonovich, K. J., Turner-Brown, L. M., Lam, K. S., Holtzclaw, T. N., & Bodfish, J. W. (2010). Performance of children with autism spectrum disorders on the dimension-change card sort task. *Journal of Autism and Developmental Disorders*, *40*(4), 448-456.

Dul, J., & Hak, T. (2008). *Case Study Methodology in Business Research*. Oxford. UK. Elsevier Ltd.

Elliott Jr, R. O., Dobbin, A. R., Rose, G. D., & Soper, H. V. (1994). Vigorous, aerobic exercise versus general motor training activities: Effects on maladaptive and stereotypic behaviors of adults with both autism and mental retardation. *Journal of Autism and Developmental Disorders*, *24*(5), 565-576.

Ellis, D. N., Maclean Jr, W. E., & Gazdag, G. (1989). The effects of exercise and cardiovascular fitness on stereotyped bodyrocking. *Journal of Behavior Therapy and Experimental Psychiatry*, *20*(3), 251-256.

Finkelstein, S., Barnes, T., Wartell, Z., & Suma, E. A. (2013). Evaluation of the exertion and motivation factors of a virtual reality exercise game for children with autism. *In Virtual and Augmented Assistive Technology*, IEEE Workshop. 11-16.

Fournier, K. A., Hass, C. J., Naik, S. K., Lodha, N., & Cauraugh, J. H. (2010). Motor coordination in autism spectrum disorders: a synthesis and meta-analysis. *Journal of Autism and Developmental Disorders*, *40*(10), 1227-1240.

Gabriels, R. L., Cuccaro, M. L., Hill, D. E., Ivers, B. J., & Goldson, E. (2005). Repetitive behaviors in autism: Relationships with associated clinical features. *Research in Developmental Disabilities*, *26*(2), 169-181.

Ganz, M. (2007). The lifetime distribution of the incremental societal costs of autism. *Archives of Pediatrics & Adolescent Medicine*, *161*(4), 343–349.

Gardenier, N. C., MacDonald, R., & Green, G. (2004). Comparison of direct observational methods for measuring stereotypic behavior in children with autism spectrum disorders. *Research in Developmental Disabilities*, *25*(2), 99-118.

Goldman, S., O'Brien, L. M., Filipek, P. A., Rapin, I., & Herbert, M. R. (2013). Motor stereotypies and volumetric brain alterations in children with autistic disorder. *Research in Autism Spectrum Disorders*, *7*(1), 82-92.

Goldman, S., Wang, C., Salgado, M. W., Greene, P. E., Kim, M., & Rapin, I. (2009). Motor stereotypies in children with autism and other developmental disorders. *Developmental Medicine and Child Neurology*, *51*(1), 30-38.

Hackel, M. E., Wolfe, G. A., Bang, S. M., & Canfield, J. S. (1992). Changes in hand function in the aging adult as determined by the Jebsen Test of Hand Function. *Physical Therapy*, *72*(5), 373-377.

Hagopian, L. P., & Toole, L. M. (2009). Effects of response blocking and competing stimuli on stereotypic behavior. *Behavioral Interventions*, *24*(2), 117-125.

Harrop, C., Gulsrud, A., Shih, W., Hovsepyan, L., & Kasari, C. (2015). Characterizing caregiver responses to restricted and repetitive behaviors in toddlers with autism spectrum disorder. *Autism*, *20*(3), 330-42.

Hattier, M. A., Matson, J. L., Macmillan, K., & Williams, L. (2012). Stereotyped behaviours in children with autism spectrum disorders and atypical development as measured by the BPI-01. *Developmental Neurorehabilitation*, *16*(5), 291-300.

Hattier, M. A., Matson, J. L., Tureck, K., & Horovitz, M. (2011). The effects of gender and age on repetitive and/or restricted behaviors and interests in adults with autism spectrum disorders and intellectual disability. *Research in Developmental Disabilities*, *32*(6), 2346-2351.

Hodgetts, S., Magill-Evans, J., & Misiaszek, J. E. (2011). Weighted vests, stereotyped behaviors and arousal in children with autism. *Journal of Autism and Developmental Disorders*, *41*(6), 805-814.

Hollander, E., Phillips, A., Chaplin, W., Zagursky, K., Novotny, S., Wasserman, S., & Iyengar, R. (2004). A placebo controlled crossover trial of liquid fluoxetine on repetitive behaviors in childhood and adolescent autism. *Neuropsychopharmacology*, *30*(3), 582-589.

Holtmann, M., Bölte, S., & Poustka, F. (2007). Autism spectrum disorders: Sex differences in autistic behaviour domains and coexisting psychopathology. *Developmental Medicine and Child Neurology*, *49*(5), 361-366.

Honey, E., Rodgers, J., & McConachie, H. (2012). Measurement of restricted and repetitive behaviour in children with autism spectrum disorder: Selecting a

questionnaire or interview. *Research in Autism Spectrum Disorders*, *6*(2), 757-776.

Howlin, P. (2004). Stereotyped, ritualistic and obsessional behaviours. *Autism and Asperger Syndrome preparing for adulthood* (2nd ed.), (pp. 137-172). New York, NY: Routledge.

Jang, J., Dixon, D. R., Tarbox, J., & Granpeesheh, D. (2011). Symptom severity and challenging behavior in children with ASD. *Research in Autism Spectrum Disorders*, *5*(3), 1028-1032.

Jebsen, R. H., Taylor, N. E. A. L., Trieschmann, R. B., Trotter, M. J., & Howard, L. A. (1969). An objective and standardized test of hand function. A*rchives of Physical Medicine and Rehabilitation*, *50*(6), 311.

Joosten, A. V., Bundy, A. C., & Einfeld, S. L. (2009). Intrinsic and extrinsic motivation for stereotypic and repetitive behavior. *Journal of Autism and Developmental Disorders*, *39*(3), 521-531.

Joosten, A. V., Bundy, A. C., & Einfeld, S. L. (2012). Context influences the motivation for stereotypic and repetitive behaviour in children diagnosed with intellectual disability with and without autism. *Journal of Applied Research in Intellectual Disabilities*, *25*(3), 262-271.

Kanner, L. (1943). Autistic disturbances of affective contact. *Nervous child*, 2(3), 217-250.

Kern, L. L., Koegel, R. L., & Dunlap, G. G. (1984). The influence of vigorous versus mild exercise on autistic stereotyped behaviors. J*ournal of Autism and Developmental Disorders*, *14*(1), 57-67.

Kern, L., Koegel, R. L., Dyer, K., Blew, P. A., & Fenton, L. R. (1982). The effects of physical exercise on self-stimulation and appropriate responding in autistic children. *Journal of Autism and Developmental Disorders*, *12*(4), 399-419.

King, B. H., Hollander, E., Sikich, L., McCracken, J. T., Scahill, L., Bregman, J. D., ... & Ritz, L. (2009). Lack of efficacy of citalopram in children with autism spectrum disorders and high levels of repetitive behavior: citalopram ineffective in children with autism. *Archives of General Psychiatry*, *66*(6), 583-590.

Klein, R. M., & Bell, B. (1982). Self-care skills: behavioral measurement with Klein-Bell ADL scale. *Archives of Physical Medicine and Rehabilitation*, *63*(7), 335-338.

Klintwall, L., Holm, A., Eriksson, M., Carlsson, L. H., Olsson, M. B., Hedvall, Å., ... & Fernell, E. (2011). Sensory abnormalities in autism: A brief report. *Research in Developmental Disabilities*, *32*(2), 795-800.

Koegel, R. L., & Covert, A. (1972). The relationship of self-stimulation to learning in autistic children1. *Journal of Applied Behavior Analysis*, *5*(4), 381-387

Lam, K. S. (2005). Alternative method for scoring repetitive behaviour scale-revised version [Measurement instrument].

Lam, K. S., & Aman, M. G. (2007). The Repetitive Behavior Scale-Revised: Independent validation in individuals with autism spectrum disorders. *Journal of Autism and Developmental Disorders*, *37*(5), 855-866.

Langen, M., Schnack, H. G., Nederveen, H., Bos, D., Lahuis, B. E., de Jonge, M. V., ... & Durston, S. (2009). Changes in the developmental trajectories of striatum in autism. *Biological Psychiatry*, *66*(4), 327-333.

Lanovaz, M. J. (2011). Towards a comprehensive model of stereotypy: Integrating operant and neurobiological interpretations. *Research in Developmental Disabilities*, *32*(2), 447-455.

Leekam, S. R., Prior, M. R., & Uljarevic, M. (2011). Restricted and repetitive behaviors in autism spectrum disorders: a review of research in the last decade. *Psychological Bulletin*, *137*(4), 562.

LeMonda, B. C., Holtzer, R., & Goldman, S. (2012). Relationship between executive functions and motor stereotypies in children with autistic disorder. *Research in Autism Spectrum Disorders*, *6*(3), 1099-1106.

Levinson, L. J., & Reid, G. (1993). The effects of exercise intensity on the stereotypic behaviors of individuals with autism. *Adapted Physical Activity Quarterly*, *10*(3), 255-268.

Lewis, M., & Kim, S. J. (2009). The pathophysiology of restricted repetitive behavior. *Journal of Neurodevelopmental Disorders*, *1*(2), 114-132.

Lindell, A. K., & Hudry, K. (2013). Atypicalities in cortical structure, handedness, and functional lateralization for language in autism spectrum disorders. *Neuropsychology Review*, *23*(3), 257-270.

Lochbaum, M., & Crews, D. (2003). Viability of cardiorespiratory and muscular strength programs for the adolescent with autism. *Complementary Health Practice Review*, *8*(3), 225-233.

Lopez, B. R., Lincoln, A. J., Ozonoff, S., & Lai, Z. (2005). Examining the relationship between executive functions and restricted, repetitive symptoms of autistic disorder. *Journal of Autism and Developmental Disorders*, *35*(4), 445-460.

Lovaas, O. I., Litrownik, A., & Mann, R. (1971). Response latencies to auditory stimuli in autistic children engaged in self-stimulatory behavior. *Behaviour Research and Therapy*, *9*(1), 39-49.

Lovaas, I., Newsom, C., & Hickman, C. (1987). Self-stimulatory behavior and perceptual reinforcement. *Journal of Applied Behavior Analysis*, *20*(1), 45-68.

Lydon, S., Healy, O., & Dwyer, M. (2013). An examination of heart rate during challenging behavior in Autism Spectrum Disorder. *Journal of Developmental and Physical Disabilities*, *25*(1), 149-170.

Lynch, K. B., & Bridle, M. J. (1989). Validity of the Jebsen-Taylor Hand Function Test in predicting activities of daily living. *Occupation, Participation and Health*, *9*(5), 316-318.

MacDonald, R., Green, G., Mansfield, R., Geckeler, A., Gardenier, N., Anderson, J., ... & Sanchez, J. (2007). Stereotypy in young children with autism and typically developing children. *Research in Developmental Disabilities*, *28*(3), 266-277.

Malow, B., Adkins, K. W., McGrew, S. G., Wang, L., Goldman, S. E., Fawkes, D., & Burnette, C. (2012). Melatonin for sleep in children with autism: a controlled trial examining dose, tolerability, and outcomes. *Journal of Autism and Developmental Disorders*, *42*(8), 1729-1737.

Magnusson, J. E., Cobham, C., & McLeod, R. (2012). Beneficial effects of clinical exercise rehabilitation for children and adolescents with autism spectrum disorder (ASD). *Journal of Exercise Physiology Online*, *15*(2), 71-79.

Matson, J. L., Kiely, S. L., & Bamburg, J. W. (1997). The effect of stereotypies on adaptive skills as assessed with the DASH-II and Vineland Adaptive Behavior Scales. *Research in Developmental Disabilities*, *18*(6), 471-476.

Matson, J. L., Wilkins, J., & Macken, J. (2008). The relationship of challenging behaviors to severity and symptoms of autism spectrum disorders. *Journal of Mental Health Research in Intellectual Disabilities*, *2*(1), 29-44.

McDonald, J. H. (2014). Spearman rank correlation. *Handbook of Biological Statistics* (3rd ed.), (pp.211). Baltimore, MD: Sparky House Publishing.

Ming, X., Brimacombe, M., & Wagner, G. C. (2007). Prevalence of motor impairment in autism spectrum disorders. *Brain and Development*, *29*(9), 565-570.

Morrison, K., & Rosales-Ruiz, J. (1997). The effect of object preferences on task performance and stereotypy in a child with autism. *Research in Developmental Disabilities*, *18*(2), 127-137.

Murphy, G.H., Beadle-Brown, J., Wing, L., Gould, J., Shah, A., & Holmes, N. (2005). Chronicity of challenging behaviours in people with severe intellectual disabilities and/or autism: A total population sample. J*ournal of Autism and Developmental Disorders*, *35*(4), 405-418.

Nicholson, H., Kehle, T. J., Bray, M. A., & Heest, J. V. (2011). The effects of antecedent physical activity on the academic engagement of children with autism spectrum disorder. *Psychology in the Schools*, *48*(2), 198-213.

Oriel, K. N., George, C. L., Peckus, R., & Semon, A. (2011). The effects of aerobic exercise on academic engagement in young children with autism spectrum disorder. *Pediatric Physical Therapy*, *23*(2), 187-193.

Ouellette-Kuntz, H., Coo, H., Lam, M., Breitenbach, M., Hennessey, P., Jackman, P., … Chung, A. (2014). The changing prevalence of autism in three regions of Canada. *Journal of Autism and Developmental Disorders*, *44*(1), 120-136.

Ouyang, L., Grosse, S. D., Riley, C., Bolen, J., Bishop, E., Raspa, M., & Bailey Jr, D. B. (2014). A comparison of family financial and employment impacts of fragile X syndrome, autism spectrum disorders, and intellectual disability. *Research in Developmental Disabilities*, 35(7), 1518-1527.

Pan, C. Y., & Frey, G. C. (2006). Physical activity patterns in youth with autism spectrum disorders. *Journal of Autism and Developmental Disorders*, *36*(5), 597-606.

Powers, S., Thibadeau, S., & Rose, K. (1992). Antecedent exercise and its effects on self-stimulation. *Behavioral Interventions*, 7(1), 15-22.

Prupas, A., & Reid, G. (2001). Effects of exercise frequency on stereotypic behaviors of children with developmental disabilities. *Education and Training in Mental Retardation and Developmental Disabilities*, *36*(2), 196-206.

Ravizza, S. M., Solomon, M., Ivry, R. B., & Carter, C. S. (2013). Restricted and repetitive behaviors in autism spectrum disorders: The relationship of attention and motor deficits. *Development and Psychopathology*, *25*(03), 773-784.

Richler, J., Huerta, M., Bishop, S. L., & Lord, C. (2010). Developmental trajectories of restricted and repetitive behaviors and interests in children with autism spectrum disorders. *Development and Psychopathology*, *22*(01), 55-69.

Rodgers, J., Glod, M., Connolly, B., & McConachie, H. (2012). The relationship between anxiety and repetitive behaviours in autism spectrum disorder. *Journal of Autism and Developmental Disorders*, *42*(11), 2404-2409.

Rojas, D. C., Peterson, E., Winterrowd, E., Reite, M. L., Rogers, S. J., & Tregellas, J. R. (2006). Regional gray matter volumetric changes in autism associated with social and repetitive behavior symptoms. *BioMed Central Psychiatry*, *6*, 56.

Rosenthal-Malek, A., & Mitchell, S. (1997). Brief report: The effects of exercise on the self-stimulatory behaviors and positive responding of adolescents with autism. *Journal of Autism and Developmental Disorders*, *27*(2), 193-202.

Rutter, M., Kreppner, J., Croft, C., Murin, M., Colvert, E., Beckett, C., ... & Sonuga-Barke, E. (2007). Early adolescent outcomes of institutionally deprived and non-deprived adoptees. III. Quasi-autism. *Journal of Child Psychology and Psychiatry*, *48*(12), 1200-1207.

Sacks, O. (1998). *The man who mistook his wife for a hat: And other clinical tales*. Simon and Schuster. NY

Singer, H. S. (2009). Motor stereotypies. *In Seminars in Pediatric Neurology*. *16* (2), 77-81.

Smith, L. E., Maenner, M. J., & Seltzer, M. M. (2012). Developmental trajectories in adolescents and adults with autism: The case of daily living skills. *Journal of the American Academy of Child & Adolescent Psychiatry*, *51*(6), 622-631.

Sniezyk, C. J., & Zane, T. L. (2014). Investigating the Effects of Sensory Integration Therapy in Decreasing Stereotypy. *Focus on Autism and Other Developmental Disabilities*, *doi* 1088357614525663.

Sokhadze, E. M., El-Baz, A. S., Sears, L. L., Opris, I., & Casanova, M. F. (2014). rTMS neuromodulation improves electrocortical functional measures of information processing and behavioral responses in autism. *Frontiers in Systems Neuroscience*. *8*(134),1-17.

Szatmari, P., Georgiades, S., Bryson, S., Zwaigenbaum, L., Roberts, W., Mahoney, W., ... & Tuff, L. (2006). Investigating the structure of the restricted, repetitive behaviours and interests domain of autism. J*ournal of Child Psychology and Psychiatry*, *47*(6), 582-590.

Szatmari, P., Liu, X. Q., Goldberg, J., Zwaigenbaum, L., Paterson, A. D., Woodbury-Smith, M., ... & Thompson, A. (2012). Sex differences in repetitive stereotyped behaviors in autism: implications for genetic liability. *American Journal of Medical Genetics Part B: Neuropsychiatric Genetics*, *159*(1), 5-12.

Thakkar, K. N., Polli, F. E., Joseph, R. M., Tuch, D. S., Hadjikhani, N., Barton, J. J., & Manoach, D. S. (2008). Response monitoring, repetitive behaviour and anterior cingulate abnormalities in autism spectrum disorders (ASD). *Brain*, *131*(9), 2464-2478.

Turner, M. (1999). Annotation: Repetitive behaviour in autism: A review of psychological research. *Journal of Child Psychology and Psychiatry*, *40*(6), 839-849.

Watters, R. G., & Watters, W. E. (1980). Decreasing self-stimulatory behavior with physical exercise in a group of autistic boys. *Journal of Autism and Developmental Disorders*, *10*(4), 379-387.

Wertheim, J. & Apstein, S. (2016, November 1). Defying expectations, people with autism are participating and excelling in sports. *Sports Illustrated*. Retrieved from http://www.si.com/sports-illustrated/2016/11/01/people-with-autism-spectrum-disorder-embrace-sports-athletics

Wing, L., & Potter, D. (2002). The epidemiology of autistic spectrum disorders: is the prevalence rising?. *Mental Retardation and Developmental Disabilities Research Reviews*, *8*(3), 151-161.

Wolff, J. J., Hazlett, H. C., Lightbody, A. A., Reiss, A. L., & Piven, J. (2013). Repetitive and self-injurious behaviors: associations with caudate volume in autism and fragile X syndrome. *Journal of Neurodevelopmental Disorders*, *5*(1), 12.

Yilmaz, I., Yanardag, M., Birkan, B., & Bumin, G. (2004). Effects of swimming training on physical fitness and water orientation in autism. *Pediatrics International*, *46*(5), 624-626.

APPENDICES

Appendix A: Definitions of Behaviours in People with ASD

Type	Definition	Examples
Repetitive behaviours	-a broad term used to describe a class if behaviours that are characterized by rigidity, repetition, inappropriateness and invariance (Turner, 1999) -includes both higher and lower-level behaviours (Turner, 1999)	
Higher-level behaviours	-circumscribed interests, attachment to objects, maintenance of sameness, and repetitive language (Turner, 1999)	
Circumscribed interests	-fixation on unusual details of an environment or obsession with a more common hobby (Turner, 1999)	-obsession with astronomy or serial numbers (Turner, 1999)
Restricted behaviours	-a limited range of focus and interests, as well as a strong attachment to objects (Ravizza et al., 2013)	-continuously playing the same film or music (Ravizza et al., 2013)
Insistence on sameness	-higher level behaviour (Turner, 1999) -difficulties with changes in routines or other unimportant adjustments in their environment, compulsions, and rituals (Richler et al., 2010; Cuccaro et al., 2003)	-compulsions and rituals (Szatmari, 2006; Cuccaro et al., 2003) -resistance to changes in personal routine or environment (Szatmari, 2006; Cuccaro et al., 2003)
Lower-Level behaviours	-encompasses stereotyped behaviours and repetitive manipulation of objects (Turner, 1999)	
Repetitive sensory motor behaviour	-apart from self-stimulation, these behaviours have no apparent purpose (Cuccaro et al., 2003) -similar to lower-level repetitive behaviours (Cuccaro et al., 2003)	-repetitive use of objects, hand mannerisms/ other complex mannerisms or stereotyped body movements, unusual sensory interests, rocking (Szatmari, 2006; Cuccaro et al., 2003)
Stereotyped behaviours	-purposeless movements that are done repeatedly (Ravizza et al., 2013) -behaviours that are repetitive or self-directed to varying activities or interests (Singer, 2009) -actions that are repetitive and may occur in rapid succession, have no apparent purpose (Gardenier et al., 2004)	-staring at objects, pacing, head nodding, playing in a fixed pattern rocking, vocalizations, hand mannerisms, spinning objects, lining up objects, smelling objects, non-functional closing or squinting eyes, out of context laughing, jumping… (Gardenier et al., 2004; Hattier et al., 2012; Goldman et al., 2008; Ravizza et al., 2013; Singer, 2009)

Motor stereotypies	-subdivision of stereotypies because they do not include activities such as staring at objects and playing in a fixed pattern (Singer, 2009) -patterned, repetitive, and purposeless movements (Goldman et al., 2009)	-hand flapping, finger flicking, rocking (Goldman et al., 2009)
Self-stimulatory behaviours	-a behaviour that is performed to receive desirable sensory feedback (Lovaas et al., 1987) -these behaviours can be exhibited using one's body or an object (Lovaas et al., 1987) -object manipulation that was non-functional (Powers et al., 1992)	-body-rocking, spinning, stroking, pinching one's self, rubbing interesting surfaces (Lovaas et al., 1987) -Squinting eyes (Celiberti et al., 1997)

Appendix B: The Current Literature on Exercise Reducing Repetitive Behaviours

Authors& Year	Participants	Behaviour Assessment	Intervention	Study Design	Results on RB	Other Results
Watters & Watters (1980)	-5 male children with ASD -9 to 11 years old	-Interval sampling with multiple participants** -Observation time included 8-13 observation intervals per participant	-Academic precondition: engaged in typical academic program -TV precondition: watched sesame street for 10-15 min -Exercise precondition: jogging for 8 to 10 min	-5 TV preconditions -11 Academic preconditions -11 Exercise precondition -Following preconditions: language training session	-Decrease in RB following exercise pre-condition -Mean reduction of RB is 32% -No improvement following TV or Academic precondition	-No difference in correct responding following exercise or academic precondition
Kern et al. (1982)	**Part1:** -4 out of 7 children with ASD were involved in exercise program -Average age: 5.9	-RB was recorded for 15 minutes immediately before and after intervention -Interval sampling*	-Jogging started at 5-10mintes and increased to 20 minutes. -Ball-playing or academic condition occurred before and after exercise	-Ball-playing or academic conditions were rotated -45 reversals of conditions within 21 days	-Decrease in RB after jogging	-Appropriate responding during ball-playing and academic condition increased after jogging -Inverse relationship between RB and appropriate responding
	Part 2: -3 children with ASD	-'on task' behaviours were recorded	-Jogging condition -No exercise condition	-Following exercise engagement in ball tossing or academic responding was tracked		-Higher levels of 'on task' behaviour following jogging
Bachman & Fuqua (1983)	-4 males with ID -6 to 16 years old	-Inappropriate behaviours that were assessed included repetitive movements -Behaviours tracked by interval sampling* -15-minute observations were done immediately after, 1 hour, and 2 hours after exercise -Baseline measured of inappropriate behaviours were established before beginning of phase 1	-**Phase 1**: alternating days of warm up exercises and moderate short distance jogging -**Phase 2:** alternating days no exercise condition and vigorous rate/moderate distance jogging -**Phase 3:** students jogged on consecutive days at a vigorous rate/moderate distance -**Phase 4:** Only 'student 2'jogged at vigorous pace for 3.15 km	-The number of conditions an individual participated in a phase varied (from 3 to 11 sessions) -Phase 4 and 5 were only conducted on 'Student 2'	-Phase 1: student 1&2 decrease in behaviours during jogging and warm-up exercises -Phase 2: student 1,3 & 4 decreased in behaviours. Some separation between no exercise and exercise days -Phase 3 for student 1,3 &4 there was a larger decrease in behaviours	<u>*continuation of RB results*</u> -Student 2 did not change in inappropriate behaviours from phase 1 to 4, increased a little after exercise was discontinued in phase 5

			-Phase 5: 'Student 2' engaged in non-exercise condition in phase 2			
Kern et al. (1984)	-3 children with ASD -Average age: 9.6	-RB recorded 60 minutes before and 90 minutes after each three conditions given each day -2 days in study for each participant -Interval sampling*	-Alternating session of mildly strenuous jogging and ball playing for 15 min -Ball play was considered to be mild exercise	-Alternating jogging and ball-play 3 times per day with 90minutes observation following each condition	-Decrease in RB after jogging condition -6 out of 9 ball playing session showed an increase in RB	
Bachman & Sluyter (1988)	-2 adults with ID -Subject 1 (53 years old) -Subject 2 (29 years old)	-Inappropriate behaviours included repetitive movements -Baseline observations were made before beginning intervention -15 minutes observations were made directly before and after intervention	-Aerobic dance class -45 minutes in length - intensity increased as participants learned new moves -Alternating exercise and non-exercise days	-Exercised 3 times a week -Non-exercise condition was 2 times a week	-Subject 1: inappropriate behaviours decreased on exercise days -Mean decrease for repetitive movement, was 66.8% -Similar results for Subject 2 (66.8% reduction in repetitive movement)	-Both subject 1 and 2 displayed decreases in inappropriate vocalizations and off-task behaviour
Ellis et al. (1989)	-Adult male with ID -26 years old	-Body rocking recorded by Datamyte electronic data recorder for 20 minutes -Compared baseline, intervention sessions, and post intervention measures of body rocking	-Fast walking/jogging for 20 min	-53 exercise sessions over 16 weeks	-Decline in body rocking throughout duration of study -Decrease in 43% from baseline to follow up	
Powers et al. (1992)	-A child with ID and ASD like behaviours -8 years old	-RB tracked by interval sampling* -30 minutes observation	-Roller Skating for 10 min	-Baseline (9 days), Intervention (5 days), 2nd Baseline (10 days), 2nd Intervention (10 days)	-19% mean decrease in RB in the first intervention -22% mean decrease in RB in the second intervention	-On-task behaviours increased 75% on first intervention -84% increase after second intervention
Levinson & Reid (1993)	-2 males and 1 female with ASD -11 years old	-RB tracked by interval sampling*	-Alternating 15 minutes of walking or jogging precondition per day	-Phase 1: baseline 2 weeks (three 2 hour observations)	-17.5% mean reduction in RB following jogging precondition	

		-RB recorded before and after intervention for 45 minutes each -Tracked 30 minutes again following 90 minutes break -RB divided into motor, vocal/oral and other		-Phase 2: 5-week exercise program -Phase 3: baseline 2 weeks (four 2 hour)	-Majority of motor RB decreased -RB increased 90 minutes after jogging precondition	
Elliott et al. (1994)	**Part 1:** -6 adults with ASD -Moderate to profound mental retardation -3 males -3 females -22 to 41 years old	-Groups of 3 were observed for 30 minutes before and after condition -Targeted 3 RB per person	-Non-exercise precondition: activities that did not typically increase heart rate -General motor training activities: lifting weights, stair-stepper, walking on a treadmill -Vigorous aerobic exercise: jogging on a treadmill	-5 session each of the general motor training and the vigorous aerobic exercise preconditions -1 session of the non-exercise condition	-RB decreased 65% following vigorous aerobic exercise compared to no exercise -No reductions in RB following general motor training	-Reductions in RB mainly occurred in the older individuals -57% reduction in maladaptive behaviours
	Part 2: -2 adults with ASD		-20 minutes of vigorous exercise	-Exercise occurred before community-integrated vocational task	-Reduced RB during vocational task	-Maladaptive behaviours were reduced following exercise
Celiberti et al. (1997)	-A child with mild-moderate ASD -5 year old	-RB tracked by interval sampling* for 40 min -Compared baseline measures to measures of RB after the exercise -Divided RB into visual or physical RB	-Walking or jogging for 6 min	-3 session of jogging then 2 of walking, 3 of jogging again, and 3 of walking	-31% decrease in physical RB after jogging condition -Visual RB did not decrease -No effect from walking condition on both types of RB	-Jogging reduced 'out of seat' behaviour for 50% of the sessions
Rosenthal-Malek &Mitchell (1997)	-5 adolescent males with ASD -Mean age 14.8 years old	-Interval sampling with multiple participants** -Each participant was observed for a total of 50 seconds	-Aerobic exercise precondition: mildly strenuous jogging for 20 min -Academic precondition: regular scheduled classes	-10 exercise and 10 academic preconditions -1 to 5 preconditions scheduled each week -Preconditions were followed by academic or community-based workshops	-Decrease in RB aerobic exercise precondition compared to academic precondition	-Greater number of correct responses in academic activities following exercise precondition compared to academic precondition -Greater number of tasks completed in community-based workshop following exercise precondition compared to academic precondition

Prupas & Reid (2001)	-4 children with a developmental disability -2 ASD like characteristics -2 with ASD and Fragile X syndrome -Age range: 5 to 9 years	-Videotaped RB and used interval sampling* for 15 min -Baseline RB established prior to intervention -Pre- and post-exercise RB recorded -Following end of intervention RB recorded	1. Single 10-minute walking/jogging session 2. Multiple 10-minute walking/jogging sessions throughout the day	-4 times for each treatment within 2 weeks	1. Single session: decrease in RB (51.6%) 2. Multiple sessions: larger decrease in RB throughout the day compared to single session (58.9%)	
Yilmaz et al. (2004)	-One 9 year old with ASD	-RB filmed for 45 minutes before and after exercise -Assessment was done before intervention and after intervention was complete	-Swimming education program for 60 minute	-Swimming was conducted 3 times a week for 10 weeks	-Decrease in RB following completion of swimming education program	
Anderson-Hanley et al. (2011)	-(Part 1)12 children with ASD -mean age: 14.8 years -(Part 2) 22 children with ASD -mean age: 13.2 years	-5-minute video of RB pre- and post-exercise -Coded using the Gilliam Autism Rating Scale, 2nd edition	-(Part 1) Dance Dance Revolution for 20 minutes -(Part 2) recumbent bike attached to a video game for 20 minutes	-Both Part 1&2 engaged in intervention once	-Part 1 & 2 showed a decrease in RB	-Part 1 & 2 improvements on Stroop colour test -Part 2 improvements on digits backward test
Oriel et al. (2011)	-9 children with ASD -3 to 6 years old	-Frequency of RB was recorded for 15 minute before and after intervention	-Jogging/ running for 15 minutes	-Participants were divided into two groups -One group engaged in treatment and other was the control for 3 weeks -Groups switched and continued for another 3 weeks	-Decreases in RB were not significant -5 out of 9 participants exhibited RB -Out of few RB exhibited 4 out of the 5 that exhibited RB seemed to decrease	-7 out of 9 participants improved in academic performance following exercise
Magnusson et al. (2012)	-6 participants with ASD -4 males -2 females -9 to 15 years old	-Parent questionnaire	-Aerobic and Resistance exercises for 1 hour	-Exercised twice a week until 16 session were achieved	-Decreased in negative behaviours (not statistically significant)	-Improvements in physical fitness -Increase in positive behaviours (attention to task

				-Testing days for baseline and follow-up		& positive participation in physical activity)
Bahrami et al. (2012)	-30 children with ASD -26 males -4 females -5 to 16 years old (mean: 9.13 years old) -15 in exercise group -15 in no exercise control group	-Severity of RB measured by Gilliam Autism Rating Scale-Second Edition -Administered pre-, post-14-week intervention, and 1 month follow up	-Kata training (a form of Karate) -Sessions started at 30 minutes and increased to 90 minutes	-1 session per day for 4 days per week -Total of 14 weeks	-RB severity decreased following intervention -No decrease in RB severity for controls -1 month follow-up, RB severity remain decreased	

*Interval sampling: the researcher either videotapes or observes the participant for a specified amount of time and divides that time up into sections (i.e., a minute is divided into 10 sec sections). Within these sections the observer will track whether a repetitive behaviour occurred. A percentage would be calculated from the number of sections where RB occurred and the total number of sections recorded. There are various lengths of sections that can be implemented.

**Interval sampling with multiple participants: similar concept to interval sampling, however the time observed is divided among more than one participant. (i.e., 5 seconds observing participant 1 then 5 seconds observing participant 2, etc).

Appendix C: Participant Profile

Participant Profile

Participant Name: _____

Date of Birth: _____

Weight: _____

Height: _____

Handedness: Left ☐ Right ☐ No hand dominance ☐

Gender: M ☐ F ☐

Phone Number: _____

Diagnosis: _____

_____

Description of Repetitive Behaviours:

_____

_____

_____

How many times do you engage in physical activity a week?

None ☐ Less than 1 ☐ 1-2 ☐ 2-3 ☐ more than 3 ☐

What type of physical activity do you engage in?

_____

Have you engaged in physical activity every week for a month or longer? Yes ☐ No ☐

T-shirt size: Small Medium ☐ Large ☐ X-Large ☐ XX-Large ☐

The following questions are optional. Please fill them out if you would like to be provided with a copy of your individual results from the study.

E-mail: _____

Mailing Address: _____

City: _____

Postal Code: _____

***For researcher to determine;** Seat Height: _____ holes

Appendix D: Recruitment Flyer

Effects of aerobic exercise on repetitive behaviours and the ability to perform tasks for adults with autism spectrum disorder and an intellectual disability

WHO?

- Adults with autism spectrum disorder and an intellectual disability
- Individuals who display a lot of repetitive behaviours

WHAT?

- 8 week stationary biking program

WHERE?

- Community Living Essex County

WHY?

- To determine if biking exercise can reduce the number of repetitive behaviours displayed

WHEN?

- January-March, 2015

Inclusion Criteria

- 18 years or age or older
- Diagnosed with autism spectrum disorder and an intellectual disability
- Frequently engages in repetitive behaviours
- Completed PARmed-X
- Can commit to be available for one hour, twice a week, for eight weeks
- Able to understand and follow simple instructions

University of Windsor

This study has received clearance from the University of Windsor Research Ethics Board

If you would like more information or to meet with one of the research team, please contact:

Suzanne Ali: 519-253-3000 ext. 2457 (ali11m@uwindsor.ca)
Dr. Sean Horton: 519-253-3000 ext. 2442 (hortons@uwindsor.ca)
Dr. Nadia Azar: 519-253-3000 ext. 2473 (azar5@uwindsor.ca)
Chad Sutherland: 519-253-3000 ext. 4050 (chads@uwindsor.ca)

Appendix E: Recruitment Package Completion Guide

Recruitment Package Completion Guide

- You most likely received this recruitment package from your support worker, parents, or staff at the Community Living Essex County.
- The forms in this package need to be completed before you can participate in the research study called "**Effects of aerobic exercise on repetitive behaviours and the ability to perform tasks for adults with autism spectrum disorder and an intellectual disability**".
- This package includes: a Repetitive Behaviour Scale-Revised, PARmed-X, participant profile, recruitment flyer, consent form, letter of information, parental consent form, parental letter of information, video recording consent, and availability checklist.

What to do?

- [ ] 1. Read the consent form and the letter of information. If you are willing and are able to participate in the study, please sign the consent form (you keep the letter of information).
    a. If you do not understand the consent form, there is a separate consent form and letter of information for your parents/guardians to read. If they think you would be eligible to participate in this study, then they can sign the consent form on your behalf (there is a letter of information for your parents to keep). ***Only one consent form needs to be signed**
- [ ] 2. Bring the PARmed-X form to your family doctor to see if it is safe for you to exercise.
- [ ] 3. If your doctor says it is safe for you to exercise, then read and sign the video and still recording consent forms.
- [ ] 4. Fill out the participant profile and the availability checklist.
- [ ] 5. Ask either a parent, guardian or support worker to fill out the Repetitive Behaviour Scale-Revised.
- [ ] 6. Once everything has been filled out, please return the recruitment package to Community Living Essex County. The primary researcher (Suzanne Ali) will pick it up the recruitment package from Community Living Essex County and will then contact you to schedule a familiarization date and to confirm which days we will be exercising.

****If at any time if you have questions, then please contact one of the researchers. All of our contact information is located on the recruitment flyer, consent form, and letter of information. ****

Appendix F: Consent form

University of Windsor

CONSENT TO PARTICIPATE IN RESEARCH

Title of Study: Effects of aerobic exercise on repetitive behaviours and the ability to perform tasks for adults with autism spectrum disorder and an intellectual disability

You are asked to participate in a research study led by Ms. Suzanne Ali, Dr. Sean Horton, Dr. Nadia Azar, and Mr. Chad Sutherland, from the Department of Kinesiology at the University of Windsor. This study will fulfil the schooling requirements for Suzanne Ali's Master's degree.

If you have any questions or concerns about the research, please feel to contact:

Suzanne Ali: 519-253-3000 ext. 2457 (ali11m@uwindsor.ca)
Dr. Sean Horton: 519-253-3000 ext. 2442 (hortons@uwindsor.ca)
Dr. Nadia Azar: 519-253-3000 ext. 2473 (azar5@uwindsor.ca)
Chad Sutherland: 519-253-3000 ext. 4050 (chads@uwindsor.ca)

PURPOSE OF THE STUDY

To determine:

1) If there is a change in number and duration of repetitive behaviours you show right after 20 minutes of biking.
2) If there is an improvement in your ability to do simple tasks right after biking.
3) If there is a change in the number of the repetitive behaviours you show from beginning to the end of the eight weeks of biking.

PROCEDURES

If you decide to participate in this study you will be asked to:

1) Attend a practice day (at Community Living Essex County)
2) Attend 16 sessions (two times a week for eight weeks; around 60 minutes in duration) at Community Living Essex County
3) Do other activities, which will include the following:

2 min	Signing that you are ok with today's activities
8 min	1st Simple hand skill tasks
5 min	1st Videotaped free time
5 min	Warm up
20 min	Biking exercise
3 min	Cool down
8 min	2nd Videotaped free time
5 min	2nd Simple hand skill tasks

4) Fill out a participant profile (located in this recruitment package)
5) Fill out the availability checklist (located in this recruitment package)
6) Have your doctor sign a Physical Activity Readiness Medical Examination (PARmed-X) form (located in this recruitment package).
    - ❖ This form has to be filled out and signed by your doctor before you can start the exercise program.

__NOTE__ all sessions will be completed at the Community Living Essex County (**372 Talbot Street North, Essex, ON**)

Inclusion Criteria

For you to be able to participate in the study you must:

- Be 18 years of age and older.
- Have a diagnosis of autism spectrum disorder and an intellectual disability.
- Exhibit a lot of repetitive behaviours, especially stereotypic behaviours.
    - Examples of stereotypic behaviour include: body rocking, hand mannerisms, jumping, etc.

Exclusion Criteria
You will be excluded from the study if:

- You exhibit violent/aggressive behaviour.
- Are unable to follow simple instructions and do the tasks/measurements described above.
- You do not display any stereotypic behaviour. Other forms of repetitive behaviour will not exclude you from the study as long as you display a form of stereotypic behaviour.
- You regularly exercise at a high intensity.

Rolling Consent
At the beginning of each activity day, you or your support worker/guardian will be given a rolling consent form. This form will ask if you have had any recent visits to the hospital, any changes in medication, and if you would like to exercise today.

Exercise
Trained staff will be helping you throughout the warm up exercises, 20 minutes of biking, and cool down exercises. A five-minute warm up will involve simple stretches and exercises to warm up your muscles before biking. Then you will ride an exercise bike for 20 minutes. You will be encouraged to pedal at a fast to a very fast rate for the entire 20 minutes. As you get better on the bike, the research staff may encourage you to pedal at a faster rate or to increase the difficulty on the bike. However, you are allowed to slow down and/or stop if necessary. After biking, you will be encouraged to take your time getting off the bike and do some stretching to slow your heart rate and cool down. From warm up to cool down, you will have a BODYMEDIA® armband placed on your arm. This device will track how hard you are working throughout the 20 minutes of biking.
***You should wear gym clothes and bring water to drink at every exercise session.**

Videotaped free time
You will be videotaped for eight minutes before and after biking. During this time, you are allowed to walk around the room, sit, or use with materials that will be provided, such as a puzzle or magazines. The purpose of this observation is to track how many repetitive behaviours you show during the eight minutes. Videotaping will allow the researchers to more accurately track the number and the duration of repetitive behaviours you do. This will allow the researchers to see if there is a change in the number and duration of repetitive behaviours shown after exercise.

A camera will be used to take pictures of the various methods within this study. These pictures will be used to help describe the results, and will be used for publications of this study (e.g., presentations, posters, journal articles). Your name will not be associated with the any photos and your face will not be shown in images. These photos will be saved on a password-secured computer and will only be seen by the investigators involved in this study.

Jebsen Hand Function Test
This test includes six simple activities that you have probably done many times before. Each activity will be demonstrated to you during the practice day and will be repeated if you would like to see another demonstration. You will also be videotaped during these activities to see if you engage in any repetitive behaviours. The purpose of this test is to see if there is an improvement in performance after biking.

Repetitive Behaviour Scale-Revised
Before and the end of the eight weeks of biking, your support worker or parent/guardian will be asked to fill out a repetitive behaviour questionnaire. The purpose of this questionnaire is to tell us about the types of repetitive behaviours you exhibit.

POTENTIAL RISKS AND DISCOMFORTS

A PARmed-X is provided and must be signed by a doctor prior to participating in any biking sessions including the practice day. A stationary bike was chosen to maximize safety; however, as with any exercise program you may still feel muscle soreness and fatigue. The warm up and cool down before and after biking should reduce any discomfort, and any soreness should go away within a few days.

If you experience any physical discomfort that lasts more than two weeks, then you should contact your family doctor.

You may become uncomfortable because there is a change to your schedule and you are working with unfamiliar people (researcher and volunteer). To minimize these discomforts your support worker or guardian will be with you at all bike sessions. Additionally, the same research staff will monitor and support you throughout the entire study. If you are very upset, then the researchers will try to remove anything in the study that is upsetting you. However, if you are very upset for two weeks, then we will talk with you and your support worker, parent or guardian about maybe stopping the study.

You may not like the feel of the BODYMEDIA® armband. If you do not want to wear the armband, then we will take it off and you can do the exercises without one.

POTENTIAL BENEFITS TO PARTICIPANTS AND/OR TO SOCIETY

Biking sessions will benefit you by providing an opportunity to engage in physical activity and may improve your heart and blood vessel health. Similarly, this may increase your understanding of and confidence to participate in exercise. You may decrease in the number of repetitive behaviours exhibited and improve your ability to perform activities immediately after biking, and over the course of eight weeks.

COMPENSATION FOR PARTICIPATION

You will receive a Kinesiology Research t-shirt for participating in this study.

CONFIDENTIALITY

Your anonymity (being anonymous) will not be maintained because the researcher staff will be interacting with you throughout the duration of the study. People will not know that you are in this study because we will remove your name from all of your data, and replace it with an individualized code. Your name will not be associated with your data. Data collection that involves a paper format will be labelled with only the individualized code. Additionally, a sheet relating all participant codes to their names will be only accessed by the investigators involved in this study. Furthermore, all paper data collected from this study will be kept in a secure cabinet in the Human Kinetics building at the University of Windsor and all electronic data will be stored on a password-secured computer. All results, including video observations, will be stored according to your individualized code. Videotapes will be deleted once the data has been published. Your results will be retained at the conclusion of the study, as they may be valuable for further analysis. You will be allowed to review all video recordings if you ask. If you let us take pictures of you, then we will make sure your face isn't showing in the pictures.

PARTICIPATION AND WITHDRAWAL

You can withdraw (stop your participation in this study) at any time by informing any member of the researcher team, and/or notifying your support worker/guardian. You will also be given the option to stop exercising or other activities that day and still be in the study. Furthermore, the investigator may withdraw you from this research if circumstances arise which warrant doing so.

If you withdraw from the study you have the right to ask for all data to be removed. Once data collection has been completed you will be unable to withdraw your data from the study.

FEEDBACK OF THE RESULTS OF THIS STUDY TO THE PARTICIPANTS

After all data is collected and assessed, you will receive a report on your individual results. This report will include graphs of the Jebsen Hand Function Test and video observation scores and provide summaries to describe your progress through the study.

This report can be either sent by mail or e-mail, depending on your preference. In addition, overall study results will be available on the University of Windsor's Research Ethics Board website.

Web address: http://www1.uwindsor.ca/reb/study-results
Date when results are available: May 31, 2016

SUBSEQUENT USE OF DATA

These data, including still photographs, may be used in future studies, in publications, presentation/posters

for academic conferences, and academic lectures.

Within these uses, your results will be de-identified by removing your name to ensure confidentiality. This will allow group and/or individual results to be discussed without linking specific results to you.

There is currently no intention to reanalyze the data. However, we acknowledge that the data gathered from this study may be valuable for future studies. Data will be kept indefinitely to allow us to reanalyze the data if future research opportunities arise.

RIGHTS OF RESEARCH PARTICIPANTS

If you have questions regarding your rights as a research participant, contact: Research Ethics Coordinator, University of Windsor, Windsor, Ontario, N9B 3P4; Telephone: 519-253-3000, ext. 3948; e-mail: ethics@uwindsor.ca

SIGNATURE OF RESEARCH PARTICIPANT/LEGAL REPRESENTATIVE

I understand the information provided for the study ***Effects of aerobic exercise on repetitive behaviours and the ability to perform tasks for adults with autism spectrum disorder and an intellectual disability*** as described herein. My questions have been answered to my satisfaction, and I agree to participate in this study. I have been given a copy of this form.

_____
Name of Participant

_____ _____
Signature of Participant Date

SIGNATURE OF INVESTIGATOR

These are the terms under which I will conduct research.

_____ _____
Signature of Investigator Date

Appendix G: Letter of Information

University of Windsor

LETTER OF INFORMATION FOR CONSENT TO PARTICIPATE IN RESEARCH

Title of Study: Effects of aerobic exercise on repetitive behaviours and the ability to perform tasks for adults with autism spectrum disorder and an intellectual disability

You are asked to participate in a research study led by Ms. Suzanne Ali, Dr. Sean Horton, Dr. Nadia Azar, and Mr. Chad Sutherland, from the Department of Kinesiology at the University of Windsor. This study will fulfil the schooling requirements for Suzanne Ali's Master's degree.

If you have any questions or concerns about the research, please feel to contact:

Suzanne Ali: 519-253-3000 ext. 2457 (ali11m@uwindsor.ca)
Dr. Sean Horton: 519-253-3000 ext. 2442 (hortons@uwindsor.ca)
Dr. Nadia Azar: 519-253-3000 ext. 2473 (azar5@uwindsor.ca)
Chad Sutherland: 519-253-3000 ext. 4050 (chads@uwindsor.ca)

PURPOSE OF THE STUDY

To determine:
1) If there is a change in number and duration of repetitive behaviours you show right after 20 minutes of biking.
2) If there is an improvement in your ability to do simple tasks right after biking.
3) If there is a change in the number of the repetitive behaviours you show from beginning to the end of the eight weeks of biking.

PROCEDURES

If you decide to participate in this study you will be asked to:
1) Attend a practice day (at Community Living Essex County)
2) Attend 16 sessions (two times a week for eight weeks; around 60 minutes in duration) at Community Living Essex County
3) Do other activities, which will include the following:

2 min	Signing that you are ok with today's activities
8 min	1st Simple hand skill tasks
5 min	1st Videotaped free time
5 min	Warm up
20 min	Biking exercise
3 min	Cool down
8 min	2nd Videotaped free time
5 min	2nd Simple hand skill tasks

4) Fill out a participant profile (located in this recruitment package)
5) Fill out the availability checklist (located in this recruitment package)
6) Have your doctor sign a Physical Activity Readiness Medical Examination (PARmed-X) form (located in this recruitment package).
    - ❖ This form has to be filled out and signed by your doctor before you can start the exercise program.

__NOTE__ all sessions will be completed at the Community Living Essex County (**372 Talbot Street North, Essex, ON**)

Inclusion Criteria
For you to be able to participate in the study you must:
- Be 18 years of age and older.
- Have a diagnosis of autism spectrum disorder and an intellectual disability.
- Exhibit a lot of repetitive behaviours, especially stereotypic behaviours.
    - Examples of stereotypic behaviour include: body rocking, hand mannerisms, jumping, etc.

Exclusion Criteria
You will be excluded from the study if:
- You exhibit violent/aggressive behaviour.
- Are unable to follow simple instructions and do the tasks/measurements described above.
- You do not display any stereotypic behaviour. Other forms of repetitive behaviour will not exclude you from the study as long as you display a form of stereotypic behaviour.
- You regularly exercise at a high intensity.

Rolling Consent
At the beginning of each activity day, you or your support worker/guardian will be given a rolling consent form. This form will ask if you have had any recent visits to the hospital, any changes in medication, and if you would like to exercise today.

Exercise
Trained staff will be helping you throughout the warm up exercises, 20 minutes of biking, and cool down exercises. A five-minute warm up will involve simple stretches and exercises to warm up your muscles before biking. Then you will ride an exercise bike for 20 minutes. You will be encouraged to pedal at a fast to a very fast rate for the entire 20 minutes. As you get better on the bike, the research staff may encourage you to pedal at a faster rate or to increase the difficulty on the bike. However, you are allowed to slow down and/or stop if necessary. After biking, you will be encouraged to take your time getting off the bike and do some stretching to slow your heart rate and cool down. From warm up to cool down, you will have a BODYMEDIA® armband placed on your arm. This device will track how hard you are working throughout the 20 minutes of biking.
***You should wear gym clothes and bring water to drink at every exercise session.**

Videotaped free time
You will be videotaped for eight minutes before and after biking. During this time, you are allowed to walk around the room, sit, or use with materials that will be provided, such as a puzzle or magazines. The purpose of this observation is to track how many repetitive behaviours you show during the eight minutes. Videotaping will allow the researchers to more accurately track the number and the duration of repetitive behaviours you do. This will allow the researchers to see if there is a change in the number and duration of repetitive behaviours shown after exercise.

A camera will be used to take pictures of the various methods within this study. These pictures will be used to help describe the results, and will be used for publications of this study (e.g., presentations, posters, journal articles). Your name will not be associated with the any photos and your face will not be shown in images. These photos will be saved on a password-secured computer and will only be seen by the investigators involved in this study.

Jebsen Hand Function Test
This test includes six simple activities that you have probably done many times before. Each activity will be demonstrated to you during the practice day and will be repeated if you would like to see another demonstration. You will also be videotaped during these activities to see if you engage in any repetitive behaviours. The purpose of this test is to see if there is an improvement in performance after biking.

Repetitive Behaviour Scale-Revised
Before and the end of the eight weeks of biking, your support worker or parent/guardian will be asked to fill out a repetitive behaviour questionnaire. The purpose of this questionnaire is to tell us about the types of repetitive behaviours you exhibit.

POTENTIAL RISKS AND DISCOMFORTS
A PARmed-X is provided and must be signed by a doctor prior to participating in any biking sessions including the practice day. A stationary bike was chosen to maximize safety; however, as with any exercise program

you may still feel muscle soreness and fatigue. The warm up and cool down before and after biking should reduce any discomfort, and any soreness should go away within a few days.
If you experience any physical discomfort that lasts more than two weeks, then you should contact your family doctor.

You may become uncomfortable because there is a change to your schedule and you are working with unfamiliar people (researcher and volunteer). To minimize these discomforts your support worker or guardian will be with you at all bike sessions. Additionally, the same research staff will monitor and support you throughout the entire study. If you are very upset, then the researchers will try to remove anything in the study that is upsetting you. However, if you are very upset for two weeks, then we will talk with you and your support worker, parent or guardian about maybe stopping the study.

You may not like the feel of the BODYMEDIA® armband. If you do not want to wear the armband, then we will take it off and you can do the exercises without one.

POTENTIAL BENEFITS TO PARTICIPANTS AND/OR TO SOCIETY

Biking sessions will benefit you by providing an opportunity to engage in physical activity and may improve your heart and blood vessel health. Similarly, this may increase your understanding of and confidence to participate in exercise. You may decrease in the number of repetitive behaviours exhibited and improve your ability to perform activities immediately after biking, and over the course of eight weeks.

COMPENSATION FOR PARTICIPATION

You will receive a Kinesiology Research t-shirt for participating in this study.

CONFIDENTIALITY

Your anonymity (being anonymous) will not be maintained because the researcher staff will be interacting with you throughout the duration of the study. People will not know that you are in this study because we will remove your name from all of your data, and replace it with an individualized code. Your name will not be associated with your data. Data collection that involves a paper format will be labelled with only the individualized code. Additionally, a sheet relating all participant codes to their names will be only accessed by the investigators involved in this study. Furthermore, all paper data collected from this study will be kept in a secure cabinet in the Human Kinetics building at the University of Windsor and all electronic data will be stored on a password-secured computer. All results, including video observations, will be stored according to your individualized code. Videotapes will be deleted once the data has been published. Your results will be retained at the conclusion of the study, as they may be valuable for further analysis. You will be allowed to review all video recordings if you ask. If you let us take pictures of you, then we will make sure your face isn't showing in the pictures.

PARTICIPATION AND WITHDRAWAL

You can withdraw (stop your participation in this study) at any time by informing any member of the researcher team, and/or notifying your support worker/guardian. You will also be given the option to stop exercising or other activities that day and still be in the study. Furthermore, the investigator may withdraw you from this research if circumstances arise which warrant doing so.

If you withdraw from the study you have the right to ask for all data to be removed. Once data collection has been completed you will be unable to withdraw your data from the study.

FEEDBACK OF THE RESULTS OF THIS STUDY TO THE PARTICIPANTS

After all data is collected and assessed, you will receive a report on your individual results. This report will include graphs of the Jebsen Hand Function Test and video observation scores and provide summaries to describe your progress through the study.

This report can be either sent by mail or e-mail, depending on your preference. In addition, overall study results will be available on the University of Windsor's Research Ethics Board website.

Web address: http://www1.uwindsor.ca/reb/study-results
Date when results are available: May 31, 2016

SUBSEQUENT USE OF DATA

These data, including still photographs, may be used in future studies, in publications, presentation/posters for academic conferences, and academic lectures.

Within these uses, your results will be de-identified by removing your name to ensure confidentiality. This will allow group and/or individual results to be discussed without linking specific results to you.

There is currently no intention to reanalyze the data. However, we acknowledge that the data gathered from this study may be valuable for future studies. Data will be kept indefinitely to allow us to reanalyze the data if future research opportunities arise.

RIGHTS OF RESEARCH PARTICIPANTS

If you have questions regarding your rights as a research participant, contact: Research Ethics Coordinator, University of Windsor, Windsor, Ontario, N9B 3P4; Telephone: 519-253-3000, ext. 3948; e-mail: ethics@uwindsor.ca

SIGNATURE OF INVESTIGATOR

These are the terms under which I will conduct research.

_____ _____

Signature of Investigator Date

Appendix H: Parental Consent form

University of Windsor

CONSENT TO PARTICIPATE IN RESEARCH

Title of Study: Effects of aerobic exercise on repetitive behaviours and the ability to perform tasks for adults with autism spectrum disorder and an intellectual disability

Your family member is asked to participate in a research study conducted by Ms. Suzanne Ali, Dr. Sean Horton, Dr. Nadia Azar, and Mr. Chad Sutherland, from the Department of Kinesiology at the University of Windsor. This study will be fulfilling the thesis requirements of Suzanne Ali's Master's degree.

If you have any questions or concerns about the research, please feel to contact:

Suzanne Ali: 519-253-3000 ext. 2457 (ali11m@uwindsor.ca)
Dr. Sean Horton: 519-253-3000 ext. 2442 (hortons@uwindsor.ca)
Dr. Nadia Azar: 519-253-3000 ext. 2473 (azar5@uwindsor.ca)
Chad Sutherland: 519-253-3000 ext. 4050 (chads@uwindsor.ca)

PURPOSE OF THE STUDY

To determine:
1) If there is an immediate change in number and duration of repetitive behaviours displayed after 20 minutes of exercise indoors on a stationary bike.
2) If there is an immediate improvement in the ability to perform simple tasks after biking.
3) If there is a long-term change in the number of the repetitive behaviours displayed from beginning to the end of the eight weeks of biking.

PROCEDURES

Individuals who decide to participate in this study will be asked to:

1) Attend a trial day where you run through a typical day's procedures to become familiar with the activities (at Community Living Essex County)
2) Attend 16 biking sessions (two times a week for eight weeks; approximately 60 minutes in duration) at Community Living Essex County
3) Engage in a typical session, which will include the following:

2 min	Signing rolling consent/assent
8 min	1st Simple manual tasks
5 min	1st Videotaped free time
5 min	Warm up
20 min	Biking exercise
3 min	Cool down
8 min	2nd Videotaped free time
5 min	2nd Simple manual tasks

4) Complete a participant profile (located in this recruitment package)
5) Complete the availability checklist (located in this recruitment package)
6) Complete a Physical Activity Readiness Medical Examination (PARmed-X) form (located in this recruitment package)
   - ❖ This form must be completed and signed by your family member's physician prior to engaging in the exercise program.

__NOTE__ all sessions will be completed at the Community Living Essex County (**372 Talbot Street North, Essex, ON**)

Inclusion Criteria

For your family member to be able to participate in the study they must:

- Be 18 years of age and older.

- Have a Diagnosis of autism spectrum disorder and an intellectual disability.
- Exhibit a lot of repetitive behaviours, especially stereotypic behaviours.
    - Examples of stereotypic behaviour include: body rocking, hand mannerisms, jumping, etc...

Exclusion Criteria

Your family member will be excluded from the study if:

- They exhibit violent/aggressive behaviour
- Are unable to follow simple instructions and perform the tasks/measurements described above.
- They do not display any stereotypic behaviour. Other forms of RB will not exclude your family member from the study as long as they exhibit a form of stereotypic behaviour.
- They regularly exercise at and very intense rate

Rolling Consent

At the beginning of each session, you, the support worker, or your family member will be given a rolling consent form. This form will ask if your family member has had any recent visits to the hospital, any changes in medication, and if they would like to engage in exercise today.

Exercise

Trained staff will be guiding your family member throughout the warm-up, 20 minutes of biking, and cool down. A five-minute warm up will involve simple stretches and exercises to warm up their muscles before biking. After the warm-up your family member will engage in 20 minutes of exercise on a stationary bike. They will be encouraged to pedal at a moderate to vigorous rate for the entire 20 minutes. As your family member progresses in their ability to exercise on the bike, the research staff may encourage you to pedal at a faster rate or to increase the resistance on the bike. However, they are allowed to lower their pace and/or stop if necessary. Following the 20 minutes of biking, your family member will be encouraged to take their time getting off the bike and engage in stretching to lower their heart rate and cool down.

* Your family member is encouraged to wear appropriate exercise clothes and to bring water to drink.

From warm up to cool down, your family member will have a BODYMEDIA® armband placed on their arm. This device will track the amount of energy your family member expense throughout the 20 minutes of biking.

Videotaped free time

Your family member will be videotaped for eight minutes before and after the 20 minutes of biking. During this time, they are allowed to walk around the room, sit, or interact with materials that will be provided, such as a puzzle or magazines. The purpose of this observation is to track how many repetitive behaviours your family member engages in during the eight minutes. Videotaping will allow the researchers to more accurately quantify the number and the duration of repetitive behaviours your family member engages in. This will allow the researchers to see if there is a change in the number and duration of repetitive behaviours displayed after exercise.

Still Recording will be used to take pictures of the various methods within this study. These pictures will be used to aid protocol descriptions within the primary researcher's thesis document, and publications of this study (e.g., presentations, posters, journal articles). Your family member's name will not be associated with the any photos and photo-editing software will be used to crop out or cover their face in the images. These photos will be saved on a password-secured computer and will only be accessed by the investigators involved in this study.

Jebsen Hand Function Test

This test includes six simple activities: turning over cards, picking up small common objects, simulated feeding, stacking checkers, picking up large light objects, and picking up large heavy objects. Each activity will be demonstrated to your family member during the trial day and will be repeated if they prefer to see another demonstration. Your family member will also be videotaped during these activities. The videotapes will be used to ensure accurate scoring and to determine if they engage in repetitive behaviours during these activities. The purpose of this test is to see if there is an improvement following exercise.

Repetitive Behaviour Scale-Revised

Before and the end of the eight weeks of biking, you or your family member's support worker will be asked to fill out a repetitive behaviour questionnaire. All questions will be on a scale from 0 (behaviour does not occur)

to 3 (behaviour occurs and is a severe problem). The purpose of this questionnaire is gain an overall understanding of the types of repetitive behaviours you exhibit.

POTENTIAL RISKS AND DISCOMFORTS

A PARmed-X is provided which is required to be signed by a doctor prior to engaging in any biking sessions including the trial session. Additionally, a stationary bike was chosen to maximize safety; however, as with any exercise program your family member may still experience muscle soreness and fatigue. The warm-up and cool-down prior to and after biking should reduce any discomfort, and any soreness should subside within a few days. If your family member experiences any physical discomforts persist past two weeks, then you should contact their family physician.

Your family member may become uncomfortable because there is a change to their schedule and they are working with unfamiliar people (researcher and volunteer). To minimize these discomforts you or the support worker will be present at all bike sessions. Additionally, the same research staff will monitor and support your family member throughout the entire program. If your family member exhibits any psychological discomfort, the researchers will adjust the intervention protocol in order to make the them feel comfortable. For example, your family member may be given more time to transition from one activity to another. If your family member dislikes wearing the BODYMEDIA® armband, it will be removed and the researchers will track biking performance by the amount of resistance on the bike and distance travelled (recorded by the bike) for each session. Furthermore, your family member can decline participation in any exercise session, while remaining in the study. If your family member continues to have psychological discomfort past two weeks, then withdrawal from the study will be discussed with them and the support worker, parent or guardian

Your family member may not like the feel of the BODYMEDIA® armband. If they do not want to wear the armband, then it will be removed and they may engage in the exercises without one.

POTENTIAL BENEFITS TO PARTICIPANTS AND/OR TO SOCIETY

Biking sessions will benefit your family member by providing an opportunity to engage in physical activity and may improve their level of cardiovascular fitness. Similarly, this may increase your family member's understanding of and confidence to participate in exercise. Your family member may decrease in the number of repetitive behaviours exhibited and improve their ability to perform activities immediately after biking, and over the course of eight weeks.

COMPENSATION FOR PARTICIPATION

Your family member will receive a Kinesiology Research t-shirt for participating in this study.

CONFIDENTIALITY

Your family member anonymity will not be maintained because the researcher staff will be interacting with them throughout the duration of the study. Confidentiality will be maintained by removing your family member's name from all of their data, which will be identified by an individualized code. Your family member's name will not be associated with their data. Data collection that involves a paper format will be labelled with only the individualized code. Additionally, a sheet relating all participant codes to their names will be only accessed by the investigators involved in this study. Furthermore, all paper data collected from this study will be kept in a secure cabinet in the Human Kinetics building at the University of Windsor and all electronic data will be stored on a password-secured computer. All results, including video observations, will be stored according to your individualized code, not your family member's name. Videotapes will be deleted once the data has been published. Your family member's results will be retained at the conclusion of the study, as they may be valuable for further analysis. Your family member will be permitted to review all video recordings upon request.

PARTICIPATION AND WITHDRAWAL

Your family member can withdraw from the study at any time by informing any member of the researcher team, and/or notifying you or the support worker. Your family member will also be given the option to decline engaging in either exercise or testing measures that day and still remain in the study. Furthermore, the investigator may withdraw your family member from this research if circumstances arise which warrant doing so.

If your family member withdraws from the study they have the right to ask for all data to be removed. Once data collection has been completed your family member will be unable to withdraw their data from the study.

FEEDBACK OF THE RESULTS OF THIS STUDY TO THE PARTICIPANTS

After all data is collected and assessed, your family member will receive a report on your individual results. This report will indicate if the eight weeks of aerobic exercise has changed the number of repetitive behaviours your family member displayed immediately following exercise and over the course of the study, and if there was an improvement in their ability to perform simple activities.

This report can be either sent by mail or e-mail, depending on your family member's preference. In addition, overall study results will be available on the University of Windsor's Research Ethics Board website.

Web address: http://www1.uwindsor.ca/reb/study-results
Date when results are available: May 31, 2016

SUBSEQUENT USE OF DATA

These data, including still photographs, may be used in future studies, in publications, presentation/posters for academic conferences, and academic lectures.

Within these uses, your family member's results will be de-identified by removing their name to ensure confidentiality. This will allow group and/or individual results to be discussed without linking specific results to your family member.

There is currently no intention to reanalyze the data. However, we acknowledge that the data gathered from this study may be valuable for future studies. Data will be kept indefinitely to allow us to reanalyze the data if future research opportunities arise.

RIGHTS OF RESEARCH PARTICIPANTS

If you have questions regarding your family member rights as a research participant, contact: Research Ethics Coordinator, University of Windsor, Windsor, Ontario, N9B 3P4; Telephone: 519-253-3000, ext. 3948; e-mail: ethics@uwindsor.ca

SIGNATURE OF RESEARCH PARTICIPANT/LEGAL REPRESENTATIVE

I understand the information provided for the study **[*Effects of aerobic exercise on repetitive behaviours and the ability to perform tasks for adults with autism spectrum disorder and an intellectual disability*]** as described herein. My questions have been answered to my satisfaction, and I agree for my family member to participate in this study. I have been given a copy of this form.

_____
Name of Participant

_____ _____
Signature of Participant Date

SIGNATURE OF INVESTIGATOR

These are the terms under which I will conduct research.

_____ _____
Signature of Investigator Date

Appendix I: Parental Letter of Information

University of Windsor

LETTER OF INFORMATION FOR CONSENT TO PARTICIPATE IN RESEARCH

Title of Study: Effects of aerobic exercise on repetitive behaviours and the ability to perform tasks for adults with autism spectrum disorder and an intellectual disability

Your family member is asked to participate in a research study conducted by Ms. Suzanne Ali, Dr. Sean Horton, Dr. Nadia Azar, and Mr. Chad Sutherland, from the Department of Kinesiology at the University of Windsor. This study will be fulfilling the thesis requirements of Suzanne Ali's Master's degree.

If you have any questions or concerns about the research, please feel to contact:

Suzanne Ali: 519-253-3000 ext. 2457 (ali11m@uwindsor.ca)
Dr. Sean Horton: 519-253-3000 ext. 2442 (hortons@uwindsor.ca)
Dr. Nadia Azar: 519-253-3000 ext. 2473 (azar5@uwindsor.ca)
Chad Sutherland: 519-253-3000 ext. 4050 (chads@uwindsor.ca)

PURPOSE OF THE STUDY

To determine:
1) If there is an immediate change in number and duration of repetitive behaviours displayed after 20 minutes of exercise indoors on a stationary bike.
2) If there is an immediate improvement in the ability to perform simple tasks after biking.
3) If there is a long-term change in the number of the repetitive behaviours displayed from beginning to the end of the eight weeks of biking.

PROCEDURES

Individuals who decide to participate in this study will be asked to:

7) Attend a trial day where you run through a typical day's procedures to become familiar with the activities (at Community Living Essex County)
8) Attend 16 biking sessions (two times a week for eight weeks; approximately 60 minutes in duration) at Community Living Essex County
9) Engage in a typical session, which will include the following:

2 min	Signing rolling consent/assent
8 min	1st Simple manual tasks
5 min	1st Videotaped free time
5 min	Warm up
20 min	Biking exercise
3 min	Cool down
8 min	2nd Videotaped free time
5 min	2nd Simple manual tasks

10) Complete a participant profile (located in this recruitment package)
11) Complete the availability checklist (located in this recruitment package)
12) Complete a Physical Activity Readiness Medical Examination (PARmed-X) form (located in this recruitment package)
    - ❖ This form must be completed and signed by your family member's physician prior to engaging in the exercise program.

__NOTE__ all sessions will be completed at the Community Living Essex County (**372 Talbot Street North, Essex, ON**)

Inclusion Criteria

For your family member to be able to participate in the study they must:

- Be 18 years of age and older.
- Have a Diagnosis of autism spectrum disorder and an intellectual disability.
- Exhibit a lot of repetitive behaviours, especially stereotypic behaviours.
    - Examples of stereotypic behaviour include: body rocking, hand mannerisms, jumping, etc...

Exclusion Criteria

Your family member will be excluded from the study if:

- They exhibit violent/aggressive behaviour
- Are unable to follow simple instructions and perform the tasks/measurements described above.
- They do not display any stereotypic behaviour. Other forms of RB will not exclude your family member from the study as long as they exhibit a form of stereotypic behaviour.
- They regularly exercise at and very intense rate

Rolling Consent

At the beginning of each session, you, the support worker, or your family member will be given a rolling consent form. This form will ask if your family member has had any recent visits to the hospital, any changes in medication, and if they would like to engage in exercise today.

Exercise

Trained staff will be guiding your family member throughout the warm-up, 20 minutes of biking, and cool down. A five-minute warm up will involve simple stretches and exercises to warm up their muscles before biking. After the warm-up your family member will engage in 20 minutes of exercise on a stationary bike. They will be encouraged to pedal at a moderate to vigorous rate for the entire 20 minutes. As your family member progresses in their ability to exercise on the bike, the research staff may encourage you to pedal at a faster rate or to increase the resistance on the bike. However, they are allowed to lower their pace and/or stop if necessary. Following the 20 minutes of biking, your family member will be encouraged to take their time getting off the bike and engage in stretching to lower their heart rate and cool down.

* Your family member is encouraged to wear appropriate exercise clothes and to bring water to drink.

From warm up to cool down, your family member will have a BODYMEDIA® armband placed on their arm. This device will track the amount of energy your family member expense throughout the 20 minutes of biking.

Videotaped free time

Your family member will be videotaped for eight minutes before and after the 20 minutes of biking. During this time, they are allowed to walk around the room, sit, or interact with materials that will be provided, such as a puzzle or magazines. The purpose of this observation is to track how many repetitive behaviours your family member engages in during the eight minutes. Videotaping will allow the researchers to more accurately quantify the number and the duration of repetitive behaviours your family member engages in. This will allow the researchers to see if there is a change in the number and duration of repetitive behaviours displayed after exercise.

Still Recording will be used to take pictures of the various methods within this study. These pictures will be used to aid protocol descriptions within the primary researcher's thesis document, and publications of this study (e.g., presentations, posters, journal articles). Your family member's name will not be associated with the any photos and photo-editing software will be used to crop out or cover their face in the images. These photos will be saved on a password-secured computer and will only be accessed by the investigators involved in this study.

Jebsen Hand Function Test

This test includes six simple activities: turning over cards, picking up small common objects, simulated feeding, stacking checkers, picking up large light objects, and picking up large heavy objects. Each activity will be demonstrated to your family member during the trial day and will be repeated if they prefer to see another demonstration. Your family member will also be videotaped during these activities. The videotapes will be used to ensure accurate scoring and to determine if they engage in repetitive behaviours during these activities. The purpose of this test is to see if there is an improvement following exercise.

Repetitive Behaviour Scale-Revised
Before and the end of the eight weeks of biking, you or your family member's support worker will be asked to fill out a repetitive behaviour questionnaire. All questions will be on a scale from 0 (behaviour does not occur) to 3 (behaviour occurs and is a severe problem). The purpose of this questionnaire is gain an overall understanding of the types of repetitive behaviours you exhibit.

POTENTIAL RISKS AND DISCOMFORTS

A PARmed-X is provided which is required to be signed by a doctor prior to engaging in any biking sessions including the trial session. Additionally, a stationary bike was chosen to maximize safety; however, as with any exercise program your family member may still experience muscle soreness and fatigue. The warm-up and cool-down prior to and after biking should reduce any discomfort, and any soreness should subside within a few days. If your family member experiences any physical discomforts persist past two weeks, then you should contact their family physician.

Your family member may become uncomfortable because there is a change to their schedule and they are working with unfamiliar people (researcher and volunteer). To minimize these discomforts you or the support worker will be present at all bike sessions. Additionally, the same research staff will monitor and support your family member throughout the entire program. If your family member exhibits any psychological discomfort, the researchers will adjust the intervention protocol in order to make the them feel comfortable. For example, your family member may be given more time to transition from one activity to another. If your family member dislikes wearing the BODYMEDIA® armband, it will be removed and the researchers will track biking performance by the amount of resistance on the bike and distance travelled (recorded by the bike) for each session. Furthermore, your family member can decline participation in any exercise session, while remaining in the study. If your family member continues to have psychological discomfort past two weeks, then withdrawal from the study will be discussed with them and the support worker, parent or guardian

Your family member may not like the feel of the BODYMEDIA® armband. If they do not want to wear the armband, then it will be removed and they may engage in the exercises without one.

POTENTIAL BENEFITS TO PARTICIPANTS AND/OR TO SOCIETY

Biking sessions will benefit your family member by providing an opportunity to engage in physical activity and may improve their level of cardiovascular fitness. Similarly, this may increase your family member's understanding of and confidence to participate in exercise. Your family member may decrease in the number of repetitive behaviours exhibited and improve their ability to perform activities immediately after biking, and over the course of eight weeks.

COMPENSATION FOR PARTICIPATION

Your family member will receive a Kinesiology Research t-shirt for participating in this study.

CONFIDENTIALITY

Your family member anonymity will not be maintained because the researcher staff will be interacting with them throughout the duration of the study. Confidentiality will be maintained by removing your family member's name from all of their data, which will be identified by an individualized code. Your family member's name will not be associated with their data. Data collection that involves a paper format will be labelled with only the individualized code. Additionally, a sheet relating all participant codes to their names will be only accessed by the investigators involved in this study. Furthermore, all paper data collected from this study will be kept in a secure cabinet in the Human Kinetics building at the University of Windsor and all electronic data will be stored on a password-secured computer. All results, including video observations, will be stored according to your individualized code, not your family member's name. Videotapes will be deleted once the data has been published. Your family member's results will be retained at the conclusion of the study, as they may be valuable for further analysis. Your family member will be permitted to review all video recordings upon request.

PARTICIPATION AND WITHDRAWAL

Your family member can withdraw from the study at any time by informing any member of the researcher team, and/or notifying you or the support worker. Your family member will also be given the option to decline engaging in either exercise or testing measures that day and still remain in the study. Furthermore, the investigator may withdraw your family member from this research if circumstances arise which warrant doing so.

If your family member withdraws from the study they have the right to ask for all data to be removed. Once data collection has been completed your family member will be unable to withdraw their data from the study.

FEEDBACK OF THE RESULTS OF THIS STUDY TO THE PARTICIPANTS

After all data is collected and assessed, your family member will receive a report on your individual results. This report will indicate if the eight weeks of aerobic exercise has changed the number of repetitive behaviours your family member displayed immediately following exercise and over the course of the study, and if there was an improvement in their ability to perform simple activities.

This report can be either sent by mail or e-mail, depending on your family member's preference. In addition, overall study results will be available on the University of Windsor's Research Ethics Board website.

Web address: http://www1.uwindsor.ca/reb/study-results
Date when results are available: May 31, 2016

SUBSEQUENT USE OF DATA

These data, including still photographs, may be used in future studies, in publications, presentation/posters for academic conferences, and academic lectures.

Within these uses, your family member's results will be de-identified by removing their name to ensure confidentiality. This will allow group and/or individual results to be discussed without linking specific results to your family member.

There is currently no intention to reanalyze the data. However, we acknowledge that the data gathered from this study may be valuable for future studies. Data will be kept indefinitely to allow us to reanalyze the data if future research opportunities arise.

RIGHTS OF RESEARCH PARTICIPANTS

If you have questions regarding your family member rights as a research participant, contact: Research Ethics Coordinator, University of Windsor, Windsor, Ontario, N9B 3P4; Telephone: 519-253-3000, ext. 3948; e-mail: ethics@uwindsor.ca

SIGNATURE OF INVESTIGATOR

These are the terms under which I will conduct research.

_____ _____

Signature of Investigator Date

Appendix J: Consent for Videotaping

CONSENT FOR VIDEOTAPING

Research Participant's Name:

Title of the Project: Effects of aerobic exercise on repetitive behaviours and the ability to perform tasks for adults with autism spectrum disorder and an intellectual disability

I consent to the video-taping of observation periods and simple activities (The Jebsen Hand Function Test) before and after biking exercises.

I understand these are voluntary procedures and that I am free to withdraw at any time by requesting that the viewing be discontinued. I also understand that my name will not be revealed to anyone and that viewing will be kept confidential. Tapes are filed by participant code only and stored in a locked cabinet.

I understand that confidentiality will be respected and the viewing of materials will be for professional use only.

_____ _____

(Signature of Parent or Guardian) **(Date)**

Or

_____ _____

(Research Subject) **(Date)**

Appendix K: Consent for Still Recording

CONSENT FOR STILL RECORDING

Research Participant's Name:

Title of the Project: Effects of aerobic exercise on repetitive behaviours and the ability to perform tasks for adults with autism spectrum disorder and an intellectual disability

I consent to the use of still recording for taking pictures of the various activities within this study.

These pictures will be used to help descriptions for the primary researcher's schooling, documents, and posters. I understand that my name will not be on any photos and my face will be hidden in the photos. These photos will be saved on a password-secured computer and will only be seen by the researchers involved in this study.

I understand these are voluntary procedures and that I am free to withdraw at any time by requesting that the still recoding is discontinued. I understand that I can continue participation in the study even if I do not want my picture taken.

I understand that confidentiality will be respected and the viewing of materials will be for professional use only.

_____ _____
(Signature of Parent or Guardian) (Date)

Or

_____ _____
(Research Subject) (Date)

Appendix L: Physical Activity Readiness Medical Examination form (PARmed-X)

Physical Activity Readiness Medical Examination (revised 2002)

PARmed-X PHYSICAL ACTIVITY READINESS MEDICAL EXAMINATION

The PARmed-X is a physical activity-specific checklist to be used by a physician with patients who have had positive responses to the Physical Activity Readiness Questionnaire (PAR-Q). In addition, the Conveyance/Referral Form in the PARmed-X can be used to convey clearance for physical activity participation, or to make a referral to a medically-supervised exercise program.

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. The PAR-Q by itself provides adequate screening for the majority of people. However, some individuals may require a medical evaluation and specific advice (exercise prescription) due to one or more positive responses to the PAR-Q.

Following the participant's evaluation by a physician, a physical activity plan should be devised in consultation with a physical activity professional (CSEP-Certified Personal Trainer™ or CSEP-Certified Exercise Physiologist™). To assist in this, the following instructions are provided:

PAGE 1: • Sections A, B, C, and D should be completed by the participant BEFORE the examination by the physician. The bottom section is to be completed by the examining physician.

PAGES 2 & 3: • A checklist of medical conditions requiring special consideration and management.

PAGE 4: • Physical Activity & Lifestyle Advice for people who do not require specific instructions or prescribed exercise.

• Physical Activity Readiness Conveyance/Referral Form - an optional tear-off tab for the physician to convey clearance for physical activity participation, or to make a referral to a medically-supervised exercise program.

This section to be completed by the participant

A PERSONAL INFORMATION:

NAME _____

ADDRESS _____

_____

TELEPHONE _____

BIRTHDATE _____ GENDER _____

MEDICAL No. _____

B PAR-Q: Please indicate the PAR-Q questions to which you answered YES

- ❑ Q 1 Heart condition
- ❑ Q 2 Chest pain during activity
- ❑ Q 3 Chest pain at rest
- ❑ Q 4 Loss of balance, dizziness
- ❑ Q 5 Bone or joint problem
- ❑ Q 6 Blood pressure or heart drugs
- ❑ Q 7 Other reason:

_____

C RISK FACTORS FOR CARDIOVASCULAR DISEASE:
Check all that apply

- ❑ Less than 30 minutes of moderate physical activity most days of the week.
- ❑ Currently smoker (tobacco smoking 1 or more times per week).
- ❑ High blood pressure reported by physician after repeated measurements.
- ❑ High cholesterol level reported by physician.
- ❑ Excessive accumulation of fat around waist.
- ❑ Family history of heart disease.

Please note: *Many of these risk factors are modifiable. Please refer to page 4 and discuss with your physician.*

D PHYSICAL ACTIVITY INTENTIONS:

What physical activity do you intend to do?

_____

_____

_____

This section to be completed by the examining physician

Physical Exam:

Ht	Wt	BP i) /
		BP ii) /

Conditions limiting physical activity:

- ❑ Cardiovascular
- ❑ Musculoskeletal
- ❑ Respiratory
- ❑ Abdominal
- ❑ Other

Tests required:

- ❑ ECG
- ❑ Blood
- ❑ Exercise Test
- ❑ Urinalysis
- ❑ X-Ray
- ❑ Other

Physical Activity Readiness Conveyance/Referral:

Based upon a current review of health status, I recommend:

Further Information:
- ❑ Attached
- ❑ To be forwarded
- ❑ Available on request

- ❑ No physical activity
- ❑ Only a medically-supervised exercise program until further medical clearance
- ❑ Progressive physical activity:
  - ❑ with avoidance of: _____
  - ❑ with inclusion of: _____
  - ❑ under the supervision of a CSEP-Certified Exercise Physiologist™
- ❑ Unrestricted physical activity–start slowly and build up gradually

CSEP | SCPE THE GOLD STANDARD IN EXERCISE SCIENCE AND PERSONAL TRAINING

1

Physical Activity Readiness
Medical Examination
(revised 2002)

PARmed-X PHYSICAL ACTIVITY READINESS MEDICAL EXAMINATION

Following is a checklist of medical conditions for which a degree of precaution and/or special advice should be considered for those who answered "YES" to one or more questions on the PAR-Q, and people over the age of 69. Conditions are grouped by system. Three categories of precautions are provided. Comments under Advice are general, since details and alternatives require clinical judgement in each individual instance.

	Absolute Contraindications	Relative Contraindications	Special Prescriptive Conditions	ADVICE
	Permanent restriction or temporary restriction until condition is treated, stable, and/or past acute phase.	Highly variable. Value of exercise testing and/or program may exceed risk. Activity may be restricted. Desirable to maximize control of condition. Direct or indirect medical supervision of exercise program may be desirable.	Individualized prescriptive advice generally appropriate: • limitations imposed; and/or • special exercises prescribed. May require medical monitoring and/or initial supervision in exercise program.	
Cardiovascular	❑ aortic aneurysm (dissecting) ❑ aortic stenosis (severe) ❑ congestive heart failure ❑ crescendo angina ❑ myocardial infarction (acute) ❑ myocarditis (active or recent) ❑ pulmonary or systemic embolism—acute ❑ thrombophlebitis ❑ ventricular tachycardia and other dangerous dysrhythmias (e.g., multi-focal ventricular activity)	❑ aortic stenosis (moderate) ❑ subaortic stenosis (severe) ❑ marked cardiac enlargement ❑ supraventricular dysrhythmias (uncontrolled or high rate) ❑ ventricular ectopic activity (repetitive or frequent) ❑ ventricular aneurysm ❑ hypertension—untreated or uncontrolled severe (systemic or pulmonary) ❑ hypertrophic cardiomyopathy ❑ compensated congestive heart failure	❑ aortic (or pulmonary) stenosis—mild angina pectoris and other manifestations of coronary insufficiency (e.g., post-acute infarct) ❑ cyanotic heart disease ❑ shunts (intermittent or fixed) ❑ conduction disturbances • complete AV block • left BBB • Wolff-Parkinson-White syndrome ❑ dysrhythmias—controlled ❑ fixed rate pacemakers	• clinical exercise test may be warranted in selected cases, for specific determination of functional capacity and limitations and precautions (if any). • slow progression of exercise to levels based on test performance and individual tolerance. • consider individual need for initial conditioning program under medical supervision (indirect or direct).
			❑ intermittent claudication	progressive exercise to tolerance
			❑ hypertension: systolic 160-180; diastolic 105+	progressive exercise; care with medications (serum electrolytes; post-exercise syncope; etc.)
Infections	❑ acute infectious disease (regardless of etiology)	❑ subacute/chronic/recurrent infectious diseases (e.g., malaria, others)	❑ chronic infections ❑ HIV	variable as to condition
Metabolic		❑ uncontrolled metabolic disorders (diabetes mellitus, thyrotoxicosis, myxedema)	❑ renal, hepatic & other metabolic insufficiency	variable as to status
			❑ obesity ❑ single kidney	dietary moderation, and initial light exercises with slow progression (walking, swimming, cycling)
Pregnancy		❑ complicated pregnancy (e.g., toxemia, hemorrhage, incompetent cervix, etc.)	❑ advanced pregnancy (late 3rd trimester)	refer to the "PARmed-X for PREGNANCY"

References:

Arraix, G.A., Wigle, D.T., Mao, Y. (1992). Risk Assessment of Physical Activity and Physical Fitness in the Canada Health Survey Follow-Up Study. **J. Clin. Epidemiol.** 45:4 419-428.

Mottola, M., Wolfe, L.A. (1994). Active Living and Pregnancy, In: A. Quinney, L. Gauvin, T. Wall (eds.), **Toward Active Living: Proceedings of the International Conference on Physical Activity, Fitness and Health.** Champaign, IL: Human Kinetics.

PAR-Q Validation Report, British Columbia Ministry of Health, 1978.

Thomas, S., Reading, J., Shephard, R.J. (1992). Revision of the Physical Activity Readiness Questionnaire (PAR-Q). **Can. J. Spt. Sci.** 17: 4 338-345.

Continued on page 3...

Physical Activity Readiness
Medical Examination
(revised 2002)

	Special Prescriptive Conditions	ADVICE
Lung	❑ chronic pulmonary disorders	special relaxation and breathing exercises
	❑ obstructive lung disease ❑ asthma	breath control during endurance exercises to tolerance; avoid polluted air
	❑ exercise-induced bronchospasm	avoid hyperventilation during exercise; avoid extremely cold conditions; warm up adequately; utilize appropriate medication.
Musculoskeletal	❑ low back conditions (pathological, functional)	avoid or minimize exercise that precipitates or exasperates e.g., forced extreme flexion, extension, and violent twisting; correct posture, proper back exercises
	❑ arthritis—acute (infective, rheumatoid; gout)	treatment, plus judicious blend of rest, splinting and gentle movement
	❑ arthritis—subacute	progressive increase of active exercise therapy
	❑ arthritis—chronic (osteoarthritis and above conditions)	maintenance of mobility and strength; non-weightbearing exercises to minimize joint trauma (e.g., cycling, aquatic activity, etc.)
	❑ orthopaedic	highly variable and individualized
	❑ hernia	minimize straining and isometrics; stregthen abdominal muscles
	❑ osteoporosis or low bone density	avoid exercise with high risk for fracture such as push-ups, curl-ups, vertical jump and trunk forward flexion; engage in low-impact weight-bearing activities and resistance training
CNS	❑ convulsive disorder not completely controlled by medication	minimize or avoid exercise in hazardous environments and/or exercising alone (e.g., swimming, mountain climbing, etc.)
	❑ recent concussion	thorough examination if history of two concussions; review for discontinuation of contact sport if three concussions, depending on duration of unconsciousness, retrograde amnesia, persistent headaches, and other objective evidence of cerebral damage
Blood	❑ anemia—severe (< 10 Gm/dl) ❑ electrolyte disturbances	control preferred; exercise as tolerated
Medications	❑ antianginal ❑ antiarrhythmic ❑ antihypertensive ❑ anticonvulsant ❑ beta-blockers ❑ digitalis preparations ❑ diuretics ❑ ganglionic blockers ❑ others	NOTE: consider underlying condition. Potential for: exertional syncope, electrolyte imbalance, bradycardia, dysrhythmias, impaired coordination and reaction time, heat intolerance. May alter resting and exercise ECG's and exercise test performance.
Other	❑ post-exercise syncope	moderate program
	❑ heat intolerance	prolong cool-down with light activities; avoid exercise in extreme heat
	❑ temporary minor illness	postpone until recovered
	❑ cancer	if potential metastases, test by cycle ergometry, consider non-weight bearing exercises; exercise at lower end of prescriptive range (40-65% of heart rate reserve), depending on condition and recent treatment (radiation, chemotherapy); monitor hemoglobin and lymphocyte counts; add dynamic lifting exercise to strengthen muscles, using machines rather than weights.

*Refer to special publications for elaboration as required

The following companion forms are available online: http://www.csep.ca/forms

The **Physical Activity Readiness Questionnaire (PAR-Q) -** a questionnaire for people aged 15-69 to complete before becoming much more physically active.

The **Physical Activity Readiness Medical Examination for Pregnancy (PARmed-X for PREGNANCY) -** to be used by physicians with pregnant patients who wish to become more physically active.

For more information, please contact the:

Canadian Society for Exercise Physiology
370-18 Louisa Ottawa, ON K1R 6Y6
Tel. 1-877-651-3755 • FAX (613) 234-3565 • Online: www.csep.ca

Note to physical activity professionals...

It is a prudent practice to retain the completed Physical Activity Readiness Conveyance/Referral Form in the participant's file.

CSEP | SCPE
THE GOLD STANDARD IN EXERCISE SCIENCE AND PERSONAL TRAINING

Continued on page 4...

3

Physical Activity Readiness
Medical Examination
(revised 2002)

PARmed-X PHYSICAL ACTIVITY READINESS MEDICAL EXAMINATION

PARmed-X Physical Activity Readiness Conveyance/Referral Form

Based upon a current review of the health status of _____, I recommend:

- ❑ No physical activity
- ❑ Only a medically-supervised exercise program until further medical clearance
- ❑ Progressive physical activity
  - ❑ with avoidance of: _____
  - ❑ with inclusion of: _____
  - ❑ under the supervision of a CSEP-Certified Exercise Physiologist™
- ❑ Unrestricted physical activity — start slowly and build up gradually

Further Information:
- ❑ Attached
- ❑ To be forwarded
- ❑ Available on request

Physician/clinic stamp:

_____ M.D.

_____ 20_____
(date)

NOTE: This physical activity clearance is valid for a maximum of six months from the date it is completed and becomes invalid if your medical condition becomes worse.

4

Appendix M: Rolling Consent Form

Sign In Sheet

Week 1 – Session 1

Hospital visits since we last saw you? YES ☐ NO ☐

Comments: _____

_____

Medication change since we last saw you? YES ☐ NO ☐

Comments: _____

_____

Would you like to participate in exercise today? Y ES ☐ NO ☐

_____ _____

Signature of Participant/Support Worker Date

Week 1 – Session 2

Hospital visits since we last saw you? YES ☐ NO ☐

Comments: _____

_____

Medication change since we last saw you? YES ☐ NO ☐

Comments: _____

_____

Would you like to participate in exercise today? Y ES ☐ NO ☐

_____ _____

Signature of Participant/Support Worker Date

Appendix N: Availability Checklist

Availability Checklist

Please place a ✓ in the following boxes below to indicate when you would be available to participant in our study starting **January 18, 2015**.

On both **Mondays** and **Wednesdays,** I can attend a one-hour session at:

- 11:15 am to 12:15pm ☐
- 12:30 pm to 1:30pm ☐
- 1:45 pm to 2:45pm ☐
- 3:00 pm to 4:00 pm ☐
- 4:15 pm to 5:15 pm ☐
- 5:30 pm to 6:30pm ☐

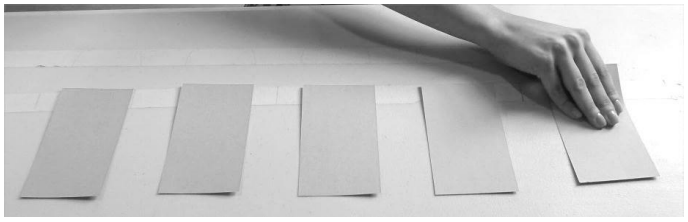
On both **Tuesdays** and **Thursdays,** I can attend a one-hour session at:

- 9:00 am to 10:00am ☐
- 10:15 am to 11:15am ☐
- 11:30 am to 12:30 pm ☐
- 12:45 pm to 1:45 pm ☐

NOTE:
- The first day of participation is a familiarization day and may last slightly longer than an hour
- **The PARmed-X must be signed BEFORE you can participate in the familiarization day**

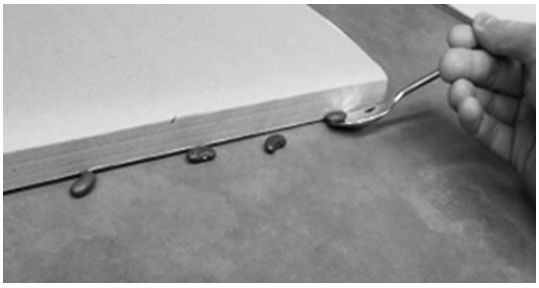
Appendix O: Jebsen Hand Function Test

Card turning.



Small Common Objects.

Simulated Feeding.



Checkers.

Large Light Objects &Large Heavy Objects.

Appendix P: Repetitive Behaviour Scale- Revised (RBS-R)

REPETITIVE BEHAVIOR SCALE – Revised (RBS-R)

Name: _____ **ID#**: _____

Gender: female male **Date of Birth**: ___ / ___ / _____ **Today's Date**: ___ / ___ / _____

Informant's Name: _____

Instructions:
Please rate this person's behavior by reading each of the items listed and then choosing the score that best describes how much of a problem the item is for the person. Be sure to read and score all items listed. Make your ratings based on your observations and interactions with the person over the last month. Use the definitions in the box given below to score each item.

0 = behavior does not occur
1 = behavior occurs and is a mild problem
2 = behavior occurs and is a moderate problem
3 = behavior occurs and is a severe problem

When deciding on a score for each item, consider: (a) how frequently the behavior occurs (e.g. weekly versus hourly), (b) how difficult it is to interrupt the behavior (e.g. can be easily redirected versus becomes distressed if interrupted) and (c) how much the behavior interferes with ongoing events (e.g. easy to ignore versus very disruptive).

I. Stereotyped Behavior Subscale

(DEFINITION: apparently purposeless movements or actions that are repeated in a similar manner)

1	WHOLE BODY (Body rocking, Body swaying)	0	1	2	3
2	HEAD (Rolls head, Nods head, Turns head)	0	1	2	3
3	HAND/FINGER (Flaps hands, Wiggles or flicks fingers, Claps hands, Waves or shakes hand or arm)	0	1	2	3
4	LOCOMOTION (Turns in circles, Whirls, Jumps, Bounces)	0	1	2	3
5	OBJECT USAGE (Spins or twirls objects, Twiddles or slaps or throws objects, Lets objects fall out of hands)	0	1	2	3
6	SENSORY (Covers eyes, Looks closely or gazes at hands or objects, Covers ears, Smells or sniffs items, Rubs surfaces)	0	1	2	3

0 = behavior does not occur 1 = behavior occurs and is a mild problem 2 = behavior occurs and is a moderate problem 3 = behavior occurs and is a severe problem

II. Self-Injurious Behavior Subscale

(DEFINITION: movement or actions that have the potential to cause redness, bruising, or other injury to the body, and that are repeated in a similar manner)

7	HITS SELF WITH BODY PART (Hits or slaps head, face, or other body area)	0	1	2	3
8	HITS SELF AGAINST SURFACE OR OBJECT (Hits or bangs head or other body part on table, floor or other surface)	0	1	2	3
9	HITS SELF WITH OBJECT (Hits or bangs head or other body area with objects)	0	1	2	3
10	BITES SELF (Bites hand, wrist, arm, lips or tongue)	0	1	2	3
11	PULLS (Pulls hair or skin)	0	1	2	3
12	RUBS OR SCRATCHES SELF (Rubs or scratches marks on arms, leg, face or torso)	0	1	2	3
13	INSERTS FINGER OR OBJECT (Eye-poking, Ear-poking)	0	1	2	3
14	SKIN PICKING (Picks at skin on face, hands, arms, legs or torso)	0	1	2	3

III. Compulsive Behavior Subscale

(DEFINITION: behavior that is repeated and is performed according to a rule, or involves things being done "just so")

15	ARRANGING / ORDERING (Arranges certain objects in a particular pattern or place; Need for things to be even or symmetrical)	0	1	2	3
16	COMPLETENESS (Must have doors opened or closed; Takes all items out of a container or area)	0	1	2	3
17	WASHING / CLEANING (Excessively cleans certain body parts; Picks at lint or loose threads)	0	1	2	3
18	CHECKING (Repeatedly checks doors, windows, drawers, appliances, clocks, locks, etc.)	0	1	2	3
19	COUNTING (Counts items or objects; Counts to a certain number or in a certain way)	0	1	2	3
20	HOARDING/SAVING (Collects, hoards or hides specific items)	0	1	2	3
21	REPEATING (Need to repeat routine events; In / out door, up / down from chair, clothing on/off)	0	1	2	3
22	TOUCH / TAP (Need to touch, tap, or rub items, surfaces, or people)	0	1	2	3

0 = behavior does not occur
1 = behavior occurs and is a mild problem
2 = behavior occurs and is a moderate problem
3 = behavior occurs and is a severe problem

IV. Ritualistic Behavior Subscale

(DEFINITION: performing activities of daily living in a similar manner)

23	EATING / MEALTIME (Strongly prefers/insists on eating/drinking only certain things; Eats or drinks items in a set order; Insists that meal related items are arranged in a certain way)	0	1	2	3
24	SLEEPING / BEDTIME (Insists on certain pre-bedtime routines; Arranges items in room "just so" prior to bedtime; Insists that certain items be present with him/her during sleep; Insists that another person be present prior to or during sleep)	0	1	2	3
25	SELF-CARE – BATHROOM AND DRESSING (Insists on specific order of activities or tasks related to using the bathroom, to washing, showering, bathing or dressing; Arranges items in a certain way in the bathroom or insists that bathroom items not be moved; Insists on wearing certain clothing items)	0	1	2	3
26	TRAVEL / TRANSPORTATION (Insists on taking certain routes/paths; Must sit in specific location in vehicles; Insists that certain items be present during travel, e.g., toy or material; Insists on seeing or touching certain things or places during travel such as a sign or store)	0	1	2	3
27	PLAY / LEISURE (Insists on certain play activities; Follows a rigid routine during play / leisure; Insists that certain items be present/available during play/leisure; Insists that other persons do certain things during play)	0	1	2	3
28	COMMUNICATION / SOCIAL INTERACTIONS (Repeats same topic(s) during social interactions; Repetitive questioning; Insists on certain topics of conversation; Insists that others say certain things or respond in certain ways during interactions)	0	1	2	3

V. Sameness Behavior Subscale

(DEFINITION: (resistance to change, insisting that things stay the same)

29	Insists that things remain in the same place(s) (e.g. toys, supplies, furniture, pictures, etc.)	0	1	2	3
30	Objects to visiting new places	0	1	2	3
31	Becomes upset if interrupted in what he/she is doing	0	1	2	3
32	Insists on walking in a particular pattern (e.g., straight line)	0	1	2	3
33	Insists on sitting at the same place	0	1	2	3
34	Dislikes changes in appearance or behavior of the people around him/her	0	1	2	3
35	Insists on using a particular door	0	1	2	3
36	Likes the same CD, tape, record or piece of music played continually; Likes same movie / video or part of movie / video	0	1	2	3
37	Resists changing activities; Difficulty with transitions	0	1	2	3
38	Insists on same routine, household, school or work schedule everyday	0	1	2	3
39	Insists that specific things take place at specific times	0	1	2	3

0 = behavior does not occur 1 = behavior occurs and is a mild problem 2 = behavior occurs and is a moderate problem 3 = behavior occurs and is a severe problem

VI. Restricted Behavior Subscale

(DEFINITION: Limited range of focus, interest or activity)

40	Fascination, preoccupation with one subject or activity (e.g., trains, computers, weather, dinosaurs)	0	1	2	3
41	Strongly attached to one specific object	0	1	2	3
42	Preoccupation with part(s) of object rather than the whole object (e.g., buttons on clothes, wheels on toy cars)	0	1	2	3
43	Fascination, preoccupation with movement / things that move (e.g., fans, clocks)	0	1	2	3

Scoring Summary:

1. Number of subscale items endorsed: number of items in a subscale rated 1, 2, or 3
2. Total subscale score: sum of the ratings for all of the items in a subscale
3. Overall number of items endorsed: sum of the "Number of subscale items endorsed"
4. Overall score: sum of the "Total subscale scores"

Subscale	Number of subscale items endorsed	Total subscale score
I. Stereotyped Behavior		
II. Self-injurious Behavior		
III. Compulsive Behavior		
IV. Ritualistic Behavior		
V. Sameness Behavior		
VI. Restricted Behavior		

Overall number of items endorsed	Overall Score

References for RBS-R:
Bodfish, J.W., Symons, F.J., Parker, D.E., & Lewis, M.H. (2000). Varieties of repetitive behavior in autism. Journal of Autism and Developmental Disabilities, 30, 237-243.
Bodfish, J.W., Symons, F.J., Lewis, M.H. (1999). The Repetitive Behavior Scale. Western Carolina Center Research Reports.

Appendix Q: Alternative method for scoring Repetitive Behaviour Scale- Revised Version (Lam, 2005)

The following is an alternative 5-subscale scoring solution for the RBS-R as detailed by:

Lam, K.S.L. (2004). The Repetitive Behavior Scale—Revised: Independent validation and the effects of subject variables. Unpublished doctoral dissertation, The Ohio State University, Columbus.

INSTRUCTIONS: Please fill in score (0 to 3) endorsed for each corresponding question on the RBS—R (e.g., "1" refers to question number 1 on the RBS—R). *Note: several items on the RBS-R are not included in this scoring algorithm.*
After filling in the ratings, sum each column to obtain a subscale score. Then, count the number of items endorsed for each subscale (any rating other than zero). Last, total the subscale scores and endorsement scores.

I: Stereotypic Behavior Subscale	**II: Self-Injurious Behavior Subscale**	**III: Compulsive Behavior Subscale**	**IV: Ritualistic/Sameness Behavior Subscale**	**V: Restricted Interests Subscale**
1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 6. _____ 22. _____ 42. _____ 43. _____	7. _____ 8. _____ 9. _____ 10. _____ 11. _____ 12. _____ 13. _____ 14. _____	15. _____ 16. _____ 17. _____ 18. _____ 19. _____ 20. _____	26. _____ 27. _____ 28. _____ 30. _____ 31. _____ 32. _____ 33. _____ 34. _____ 35. _____ 37. _____ 38. _____ 39. _____	36. _____ 40. _____ 41. _____
Subscale I Score: _____ (sum of the above ratings)	**Subscale II Score:** _____ (sum of the above ratings)	**Subscale III Score:** _____ (sum of the above ratings)	**Subscale IV Score:** _____ (sum of the above ratings)	**Subscale V Score:** _____ (sum of the above ratings)
Number endorsed: _____	**Number endorsed:** _____	**Number endorsed:** _____	**Number endorsed:** _____	**Number endorsed:** _____

Total Score (sum of all five subscale scores):

_____

Total Number Endorsed (sum of all five subscales numbers endorsed):

_____

Global Rating Score (Parent Global Impression, 1-100, page 7 of RBS-R)

_____

Appendix R: A Comparison of Items within the Stereotypic and Self-Injurious Subscales to the Video Observations

Dakota: Stereotyped Behaviour Subscale

RBS-R item with Examples Provided	**Pre-Intervention RBS-R Rating**	**Post-Intervention RBS-R Rating**	**RB Identified in Video Observations and Description of Trend**
Whole Body (body rocking, body swaying)	2	2	-*Body rocking*: increased
Head (rolls head, nods head, turns head)	0	1	-Did not occur in video observations
Hand/Finger (flaps hands, wiggles or flicks fingers, claps hands, waves or shakes hand or arm)	2	2	-*Hand to mouth*: decreased but occurred infrequently -*Finger movements*: decreased but occurred infrequently -*Clapping*: increased
Locomotion (turns in circles, whirls, jumps, bounces)	0	0	-*Pacing*: decreased
Object Usage (spins or twirls objects, twiddles or slaps or throws objects, lets objects fall out of hands)	1	1	-*Object to mouth*: increased -*Biting object*: increased -*Shakes object*: slight increased
Sensory (covers ears, looks closely or gazes at hands or objects, covers ears, smells or sniffs items, rub surfaces)	1	1	-*Rubbing surfaces/objects*: increased -*In front of face hand movements*: increased but occurred infrequently -*Close face*: decreased but occurred infrequently
Tap/Touch (need to touch, tap, or rub items, surfaces, or people)	2	2	-*Tapping objects*: decreased -*Using an object to tap another item*: decreased -Contact with another: decreased but occurred infrequently -Wiping/touching face: no change

Dakota: Self-Injurious Behaviour Subscale

Hits Self with Body Part (hits or slaps head, face, or other body part)	3	3	-*Slapping self*: decreased but occurred infrequently
Hits Self Against Surface or Object (hits or bangs head or other body part on table, floor or other surface)	1	2	-Did not occur in video observations
Hits Self with Object (hits or bangs head or other body area with object)	1	1	-Did not occur in video observations
Bites Self (bites hand, wrist, arm, lips or tongue)	2	3	-Biting hand/finger: peaked at the beginning and end of program
Pulls (pulls hair or skin)	0	1	-Did not occur in video observations
Rub or Scratches Self (rubs or scratches marks on arms, leg, face or torso)	2	3	-Did not occur in video observations
Inserts Finger or Object (eye-poking, ear-poking)	0	0	-Did not occur in video observations
Skin Pricking (picks at skin on face, hands, arms, legs or torso)	1	2	-Did not occur in video observations

*Note: *rubbing surfaces/objects* could be considered an example RB for either *touch/tap objects* or *sensory* items. All results regarding *rubbing surfaces/objects* from the video observations were placed in the *sensory* item category for consistency.

Morgan: Stereotyped Behaviour Subscale

RBS-R item with Examples Provided	Pre-Intervention RBS-R Rating	Post-Intervention RBS-R Rating	RB Identified in Video Observations and Description of Trend
Whole Body (body rocking, body swaying)	1	2	-*Body-rocking*: no change
Head (rolls head, nods head, turns head)	1	0	-*Head nodding/turning*: increased
Hand/Finger (flaps hands, wiggles or flicks fingers, claps hands, waves or shakes hand or arm)	2	2	-*Hand to mouth*: increased -*Finger movements*: decreased -*Cracking knuckles motion*: increased
Locomotion (turns in circles, whirls, jumps, bounces)	0	0	-*Shaking legs/tapping feet*: peaked at beginning and end of program
Object Usage (spins or twirls objects, twiddles or slaps or throws objects, lets objects fall out of hands)	0	0	- Did not occur in video observations
Sensory (covers ears, looks closely or gazes at hands or objects, covers ears, smells or sniffs items, rub surfaces)	1	1	-*Rubbing surfaces/objects*: increased -*In front of face hand movements with/without slight tapping on face*: increased
Tap/Touch (need to touch, tap, or rub items, surfaces, or people)	0	0	-*Tapping objects*: decreased -*Touching head and face*: increased -*Scratching head or face (non-injurious)*: decreased -*Rubbing or tapping another body part*: increased
Morgan: Self-Injurious Behaviour			
Hits Self with Body Part (hits or slaps head, face, or other body part)	0	0	- Did not occur in video observations
Hits Self Against Surface or Object (hits or bangs head or other body part on table, floor or other surface)	0	0	- Did not occur in video observations

Hits Self with Object (hits or bangs head or other body area with object)	0	0	- Did not occur in video observations
Bites Self (bites hand, wrist, arm, lips or tongue)	0	0	- Did not occur in video observations
Pulls (pulls hair or skin)	1	1	- Did not occur in video observations
Rub or Scratches Self (rubs or scratches marks on arms, leg, face or torso)	0	0	- Did not occur in video observations
Inserts Finger or Object (eye-poking, ear-poking)	0	0	- Did not occur in video observations
Skin Pricking (picks at skin on face, hands, arms, legs or torso)	1	1	- Did not occur in video observations

*Note: *rubbing surfaces/objects* could be considered an example RB for either *touch/tap objects* or *sensory* items. All results regarding *rubbing surfaces/objects* from the video observations were placed in the *sensory* item category for consistency.
*Note: *Tongue to cheek* was not placed in an above category and increased throughout the program in the video observations.

Reese: Stereotyped Behaviour Subscale

RBS-R item with Examples Provided	Pre-Intervention RBS-R Rating	Post-Intervention RBS-R Rating	RB Identified in Video Observations and Description of Trend
Whole Body (body rocking, body swaying)	1	2	-*Body-rocking*: decreased but occurred infrequently
Head (rolls head, nods head, turns head)	1	3	-*Head nodding/turning*: increased
Hand/Finger (flaps hands, wiggles or flicks fingers, claps hands, waves or shakes hand or arm)	2	3	-*Finger movements*: occurred infrequently -*Sticking arm straight out*: occurred infrequently -*Clapping/waving hand*: increased -*In front of face hand movements and hand to mouth* (*grouped together due to similar expressions): decreased
Locomotion (turns in circles, whirls, jumps, bounces)	2	3	-*Jumping/hopping/shrugging*: no change -*Leg movements*: no change
Object Usage (spins or twirls objects, twiddles or slaps or throws objects, lets objects fall out of hands)	*Not filled in by support worker	3	-*Object to mouth*: occurred infrequently -*Shaking/flapping objects*: increased -*Ripping book pages*: increased but occurred infrequently
Sensory (covers ears, looks closely or gazes at hands or objects, covers ears, smells or sniffs items, rub surfaces)	2	3	-*Licks finger*: increase but occurred infrequently -*Licks object*: occurred infrequently -*Blowing on an object*: occurred infrequently
Tap/Touch (need to touch, tap, or rub items, surfaces, or people)	1	3	-*Tapping an object/using an object to tap*: increased -*Wiping/touching face*: no change -*Rubbing/wiping a part of one's body*: increased but infrequent -*Rubbing surfaces/objects*: increased

Reese: Self-Injurious Behaviour

Hits Self with Body Part (hits or slaps head, face, or other body part)	1	3	-*Hitting head/nose*: no change -*Hitting another body part*: no change
Hits Self Against Surface or Object (hits or bangs head or other body part on table, floor or other surface)	0	2	-Did not occur in video observations
Hits Self with Object (hits or bangs head or other body area with object)	0	3	-*Object to tap/hit head*: increased

Bites Self (bites hand, wrist, arm, lips or tongue)	0	1	-*Biting hand*: increased but occurred infrequently
Pulls (pulls hair or skin)	0	0	-*Pulls hair*: occurred infrequently
Rub or Scratches Self (rubs or scratches marks on arms, leg, face or torso)	0	2	-Did not occur in video observations
Inserts Finger or Object (eye-poking, ear-poking)	0	1	-*Poking under eye*: decreased but occurred infrequently
Skin Pricking (picks at skin on face, hands, arms, legs or torso)	0	0	-Did not occur in video observations

*Note: *rubbing surfaces/objects* could be considered an example RB for either *touch/tap objects* or *sensory* items. All results regarding *rubbing surfaces/objects* from the video observations were placed in the *sensory* item category for consistency.

Taylor: Stereotyped Behaviour Subscale

RBS-R item with Examples Provided	Pre-Intervention RBS-R Rating	Post-Intervention RBS-R Rating	RB Identified in Video Observations and Description of Trend
Whole Body (body rocking, body swaying)	0	1	-*Body-rocking and torso-spinning*: decreased
Head (rolls head, nods head, turns head)	1	0	-*Head nodding/turning*: no change
Hand/Finger (flaps hands, wiggles or flicks fingers, claps hands, waves or shakes hand or arm)	2	1	-*Finger turning*: increased at end of the program -*Clapping*: increased at end of the program -*Moving hand in 'stop' position*: occurred infrequently -*Swinging elbow out to the side*: no change
Locomotion (turns in circles, whirls, jumps, bounces)	2	0	-Did not occur in video observations
Object Usage (spins or twirls objects, twiddles or slaps or throws objects, lets objects fall out of hands)	1	0	-*Moving hand in 'stop' position while holding an object*: occurred infrequently
Sensory (covers ears, looks closely or gazes at hands or objects, covers ears, smells or sniffs items, rub surfaces)	1	0	-*Rubbing surfaces/objects*: increased
Tap/Touch (need to touch, tap, or rub items, surfaces, or people)	1	1	-*Tapping objects*: increased at the end of the program -*Touching face/head*: slightly decreased to no change -*Rubbing stomach*: occurred infrequently -*Hand to mouth*: slightly decreased but occurred infrequently
Taylor: Self-Injurious Behaviour			
Hits Self with Body Part (hits or slaps head, face, or other body part)	0	0	-*Slaps stomach*: occurred infrequently
Hits Self Against Surface or Object (hits or bangs head or other body part on table, floor or other surface)	0	0	-Did not occur in video observations
Hits Self with Object (hits or bangs head or other body area with object)	0	0	-Did not occur in video observations
Bites Self (bites hand, wrist, arm, lips or tongue)	0	0	-Did not occur in video observations
Pulls (pulls hair or skin)	0	0	-Did not occur in video observations

Rub or Scratches Self (rubs or scratches marks on arms, leg, face or torso)	0	0	-Did not occur in video observations
Inserts Finger or Object (eye-poking, ear-poking)	0	0	-Did not occur in video observations
Skin Pricking (picks at skin on face, hands, arms, legs or torso)	1	1	-Did not occur in video observations

*Note: *rubbing surfaces/objects* could be considered an example RB for either *touch/tap objects* or *sensory* items. All results regarding *rubbing surfaces/objects* from the video observations were placed in the *sensory* item category for consistency.

Sam: Stereotyped Behaviour Subscale

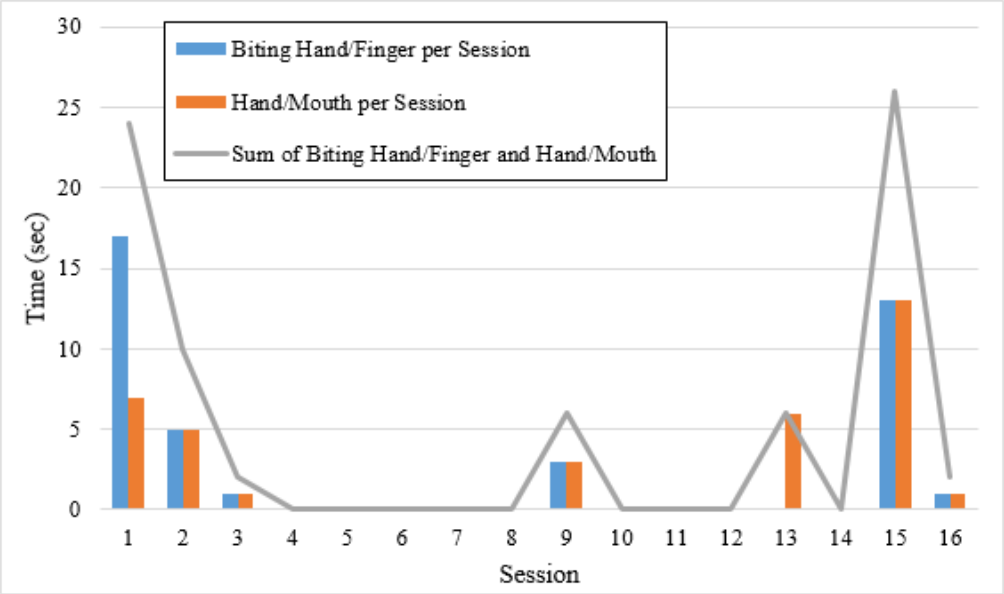
RBS-R item with Examples Provided	Pre-Intervention RBS-R Rating	Post-Intervention RBS-R Rating	RB Identified in Video Observations and Description of Trend
Whole Body (body rocking, body swaying)	0	0	-Did not occur in video observations
Head (rolls head, nods head, turns head)	1	1	-Did not occur in video observations
Hand/Finger (flaps hands, wiggles or flicks fingers, claps hands, waves or shakes hand or arm)	0	0	-Did not occur in video observations
Locomotion (turns in circles, whirls, jumps, bounces)	0	1	-Did not occur in video observations
Object Usage (spins or twirls objects, twiddles or slaps or throws objects, lets objects fall out of hands)	0	0	-Did not occur in video observations
Sensory (covers ears, looks closely or gazes at hands or objects, covers ears, smells or sniffs items, rub surfaces)	2	2	-*Rubbing surfaces/objects*: decreased at the end of the program
Tap/Touch (need to touch, tap, or rub items, surfaces, or people)	0	1	-*Tapping objects*: occurred infrequently -*Wiping/touching face*: occurred infrequently

Sam: Self-Injurious Behaviour

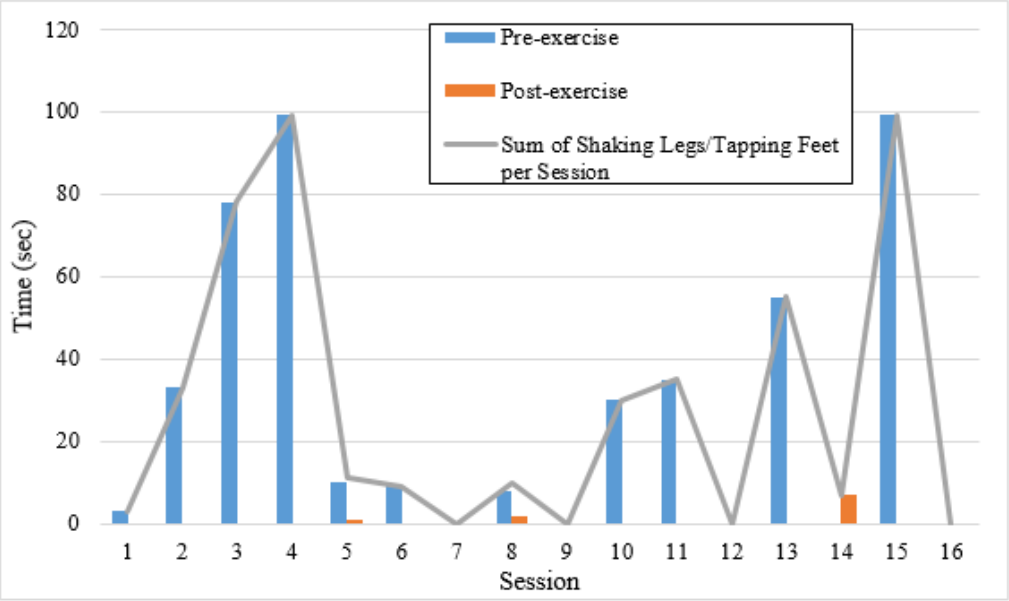
Hits Self with Body Part (hits or slaps head, face, or other body part)	0	0	-Did not occur in video observations
Hits Self Against Surface or Object (hits or bangs head or other body part on table, floor or other surface)	0	0	-Did not occur in video observations
Hits Self with Object (hits or bangs head or other body area with object)	0	0	-Did not occur in video observations
Bites Self (bites hand, wrist, arm, lips or tongue)	0	0	-Did not occur in video observations
Pulls (pulls hair or skin)	0	1	-Did not occur in video observations
Rub or Scratches Self (rubs or scratches marks on arms, leg, face or torso)	2	2	-Did not occur in video observations
Inserts Finger or Object (eye-poking, ear-poking)	0	0	-Did not occur in video observations
Skin Pricking (picks at skin on face, hands, arms, legs or torso)	1	1	-Did not occur in video observations

*Note: *rubbing surfaces/objects* could be considered an example RB for either *touch/tap objects* or *sensory* items. All results regarding *rubbing surfaces/objects* from the video observations were placed in the *sensory* item category for consistency.
*Note: An item under the Compulsive behaviour category ***Arranging/Ordering*** (arranges certain objects in a particular pattern or place; need for things to be even or symmetrical) was rated a three for both pre- and post-intervention and the video observations *fixing objects* and *fixing hair* RB decreased at the end of the program.

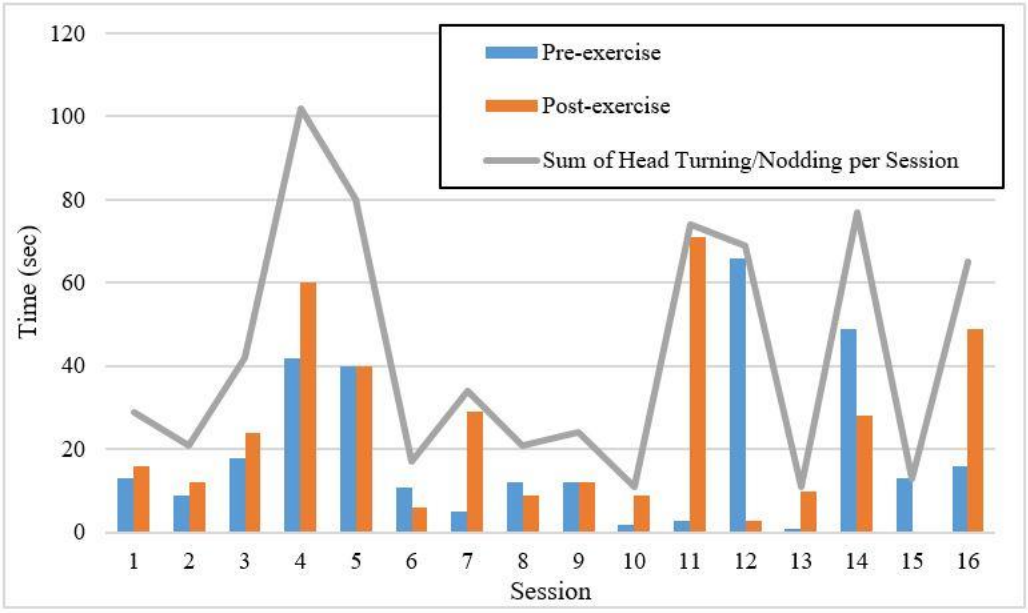
Appendix S: Supplementary Figures



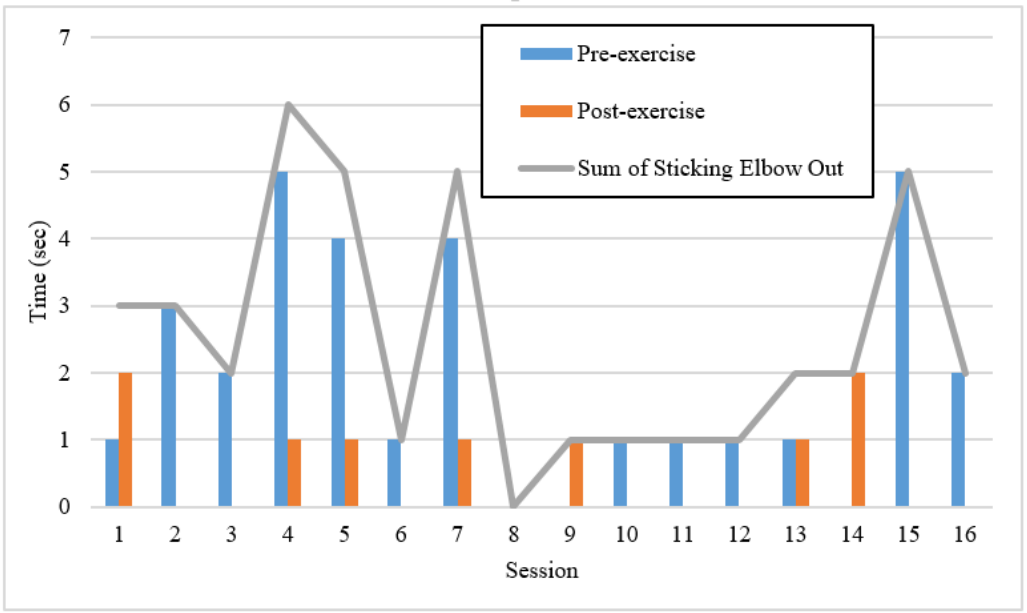
Dakota. The time spent (in seconds) engaging in *biting hand/finger* and *hand/ mouth* RB per session and the sum of both RB per session.



Morgan. The time spent (in seconds) for *shaking legs/tapping feet* RB exhibited pre/post exercise and per session.



a) Taylor: The time spent (in seconds) for *head turning/nodding* RB exhibited pre/post exercise and per session.



b) Taylor: The time spent (in seconds) for *sticking elbow out* RB exhibited pre/post exercise and per session.

Appendix T: Guidelines and Suggestions for Implementing Aerobic Exercise on a Stationary Bike for People with ASD and ID

Guidelines, Suggestions, and Examples for Implementing Aerobic Exercise on a Stationary Bike for People with ASD and ID

Future Trainers, Individuals Who Provide Support, and Researchers

Individuals wanting to administer aerobic exercise should have experience with implementing exercise. Examples of gaining experience can be through education, volunteering, involvement in exercise programs, or personal experience. Future trainers need to understand how to confidently implement exercise safely and effectively to prevent injury or adverse side effects. Additionally, a trainer needs to understand the physiological signs an individual may exhibit when he/she is exercising at a high intensity. Different tips for individuals looking to implement exercise are listed below.

- Acknowledge that physiological signs may be different for each person that you work with.
    - For example, Sam would start yawning when he reached 20 minutes of light exercise, suggesting that he was not taking in deep enough breaths. I added in breathing exercises to the warm up routine to get Sam accustomed to taking in deep breaths.
- Understand that some individuals may not have previously exercised and that you will need to explain each movement they need to complete.
    - For example, trainers will need to explain how to properly mount a bike, which direction to pedal, and where to place their hands.

  - This advice is applicable to all warm up and cool down exercises, where you may need to explain where they are to move their limbs, along with demonstrating it.
    - For example: a hamstring stretch typically called ‘touching your toes’ needs to be broken down into steps or else a participant may bend his/her knees and quickly touch his /her toes without holding the stretch. I described this stretch by saying 1) raise your hands above your head and stretch your arms toward the ceiling, 2) bend only at the waist and keep your legs straight (body should be in an ‘L’ position at this point), and 3) drop your arms and dangle your fingers to reach down and hold it.
- You may need to change the name of common exercises.
  - For example: an exercise called ‘Butt Kicks’ is where you jog on the spot and focus on getting your heel as close as possible to your lower back. I changed the name to ‘Kicking Backward’ so that no one was concerned with actually kicking themselves.
- The trial day is important to implement and allows you to understand the intensity an individual is initially comfortable exercising at with minimal encouragement. In addition, all proper adjustments to the bike to fit each person should be established on the trial day.
- Taking extensive notes on the trial and additional exercise days is important in determining: the participant’s progress throughout the program, the participant’s

current exercise intensity, and the intensity they should be working towards. Notes to take on each exercise session include:

- The level of resistance on the bike and if it was changed (increased or decreased) at any time during the exercise session.
- The speed the participant frequently exercised at, the highest speeds reached, and the number of times the participant reached those high speeds.
    - For example: On the eighth session, Reese started his biking session at 90 rpm and then consistently pedaled between 80-90 rpm. At the end of the biking session he reached a high of 120 rpm once.
- Tracking the 'distance traveled' that the exercise bike records.
- The number of times a participant slowed down or took a break in pedalling.
- The types of motivation used and its effectiveness.

<u>Suggested Methods of Verbal Encouragement</u>

- Types of cheering can include: go [name] go, fast legs, let's go [name] let's go (involved clapping), you are doing a great job, and on the count of three we are going to sprint, 1, 2 ,3, Sprint!
    - If a participant can communicate, then ask the participant if he/she is ok with clapping. If not, ask the support worker, parent, or guardian if he/she is sensitive to any specific sounds.

    - Clapping may need to be removed from a cheering song if the participant likes to mimic your movements or if clapping is one of their RB.
    - If you suspect a participant does not like loud noises, then engage in cheering songs at a lower tone but with a high intensity, expression, and large gestures.

- Use verbal cues to break down 20 minutes into chunks to make the exercise session seem more manageable.
    - For example, I would say: first five minutes; half way there; only five minutes left; you have already done 15 minutes, you can do this last five minutes.
- If the participant likes to focus on the bike screen, then make sure he/she knows what the numbers represent (i.e., where the distance and speed is tracked) and provide speed and distance goals for them to achieve.
    - If they do not focus on the speed numbers the bike displays, use alternative words of letting them know their progress (i.e., they are exercising at a medium, or fast pace). Note that if they are exercising at a slow pace, you should ask them to work toward a medium pace rather than stating that they are pedalling slowly.
- If the participant can/will communicate with you, then ask them if they are feeling ok and if they are too hot.
    - One participant preferred to be fanned with the clip board for a certain period of time and this allowed him to keep pedalling fast without getting too hot.

- Some participants may not like the feeling of resistance and will pedal a great deal slower than if there was no resistance on the bike. To avoid this, you could increase the resistance in small increments within a session or throughout a number of sessions. An additional option is to focus on increasing the participant's pace of pedalling. This may involve encouraging the participant to increase their average pedalling rate or to increase the number of times they sprint on the bike.
- You may need to exercise yourself. This may provide a sense of comradery if you are exercising with the participant rather than solely focusing on their performance.
    - Try to get a second stationary bike and exercise with the participant.
    - If you do not have a second bike you can exercise by jogging on the spot next to the bike.
    - While you are exercising with the participant you can demonstrate how fast their legs should be moving, particularly if you asked them to sprint for a certain period of time.
- You can use exercising yourself as a reward for the participant achieving a certain speed or distance.
    - For example: Once Morgan would reach a speed of 100 rpm I would do a push-up.
    - Exercise as a reward will need to be alternated between different types of quick movements such as jumping jacks or burpees. I developed a few exercises to keep Morgan interested in getting his reward. An example of

one if these made-up exercises was called a ‘crab dance’. This involved getting on my hands and feet with my stomach facing the ceiling and I would kick my legs in front of me.

- Note that using exercise as a reward may indirectly encourage the volunteer and/or support worker to show more enthusiasm while cheering.

- For some participants, you may need to redirect their attention back to pedalling. This can include:
  - Creating a make-believe racing game (e.g., if the participant is pedalling slower, then pretend to jog faster than him/her until he/she reaches a higher speed).
  - Cover up features in a room that are distracting. For example, Morgan enjoyed reading any words that were in proximity to him. As a result, I would cover up a magazine shelf that was next to the bike before he started his exercise.
  - You may want to disrupt bouts of self-talk if it is distracting the participant from exercising (consult the participant’s support worker, parent, or guardian on their understanding of the purpose of the participant’s self-talk). Examples of redirecting attention to exercising include:
    - Saying to the participant to focus on moving their legs quickly, or redirecting their attention to the speed at which they are currently exercising.

    - Saying something they enjoy focusing on. For example, one participant, Sam, liked to count so I would start saying 1, 2, 3, etc. for a few seconds and once he was focused on what I was saying then I would reintroduce verbal encouragement for biking. Reese's support worker would sing 'yellow submarine' to help Reese direct his attention and then his support worker and I would follow up with verbal encouragement to pedal faster. Note that this technique only worked with the support worker that attended music therapy classes with him.

- Some participants may be capable of pedalling fast on the bike, but might use up their energy during the beginning of the biking session. In order to keep participants pedalling for the full time on the bike, you may need to start the program by encouraging them to pedal at a medium pace rather than a fast pace. This will develop their endurance to be able to complete the full 20 minutes of biking. Once the participant is exercising at a moderate intensity throughout the biking session, then progressively add bouts of sprinting to increase the intensity. Another option is to allow the participant to exercise at a high intensity for short periods and throughout the day.
- Encouragement should be positive rather than negative. For example: instead of telling a participant they are pedalling too slow, instead try to say you are almost at [speed goal] let's keep going to get you there. All individuals who are planning to implement exercise should understand that exercise is hard enough and that you should always try to make it a positive experience. You want the participant to

feel comfortable exercising in front of you and in turn they may follow your suggestions more frequently.

- If exercising on a stationary bike does not work, then you may need to provide a different form of aerobic exercise such as jumping-jacks, jumping on a mini-trampoline, running, or swimming.

Overall, be open-minded to different ways of motivating an individual. Also, understand that some days one method works well and another day it might not. You should be continually trying previously-used methods and trying to develop new ones until you find something that works for a participant that day. In my experience, the most important factor influencing another person's biking performance is the level of enthusiasm you have. Additionally, some participants would benefit from me continually encouraging them to pedal versus others who seemed to prefer intermittent breaks in cheering. Thus, methods of cheering are participant-specific and you will need to adapt to what works best for them.

VITA AUCTORIS

NAME	Suzanne Hafiza Ali
PLACE OF BIRTH	Windsor, ON
YEAR OF BIRTH	1991
EDUCATION	Belle River District High School, Windsor, ON, 2009
	University of Windsor, B.H.K., Windsor, ON, 2013
	University of Windsor, M.H.K., Windsor, ON, 2016